DOCUMENT RESUME

ED 160 371 SE 024 846

TITLE	Development Projects in Science Education: Precollege, Higher Education, Continuing Education.
INSTITUTION	National Science Foundation, Washington, D.C.
REPORT NO	NSF-SE-77-80
PUB DATE	Sep 77
NOTE	438p.; Not available in hard copy due to marginal legibility of original document
EDRS PRICE	MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS	*Adult Education; Chemistry; Engineering; Federal Programs; *Higher Education; *High Schools; Mathematics; *Physical Sciences; Physics; Projects; *Research Projects; Science Education
IDENTIFIERS	National Science Foundation

ABSTRACT

This publication of the National Science Foundation (NSF) provides basic information and brief descriptions of experimental projects supported by NSF's Division of Science Education Development and Research in the areas of science, mathematics and engineering. The projects are grouped under their principal discipline. Indices are arranged by level of education - precollege, higher education, continuing education - and project director and are provided at the beginning of this publication. (GA)

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ED 160 371

Development Projects in Science Education

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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— Precollege
— Higher Education
— Continuing Education

SE 024 846

National Science Foundation
September 1977

INTRODUCTION

Over the past few years there has been experimentation with new courses, curricula, teaching hardware, and other mechanisms designed to provide more and better options for the student. In the areas of science, mathematics and engineering, many of these experimental projects have been supported by the National Science Foundation. Directors of projects currently supported by NSF's Division of Science Education Development and Research programs have been asked to prepare brief descriptions of their activities, and these are presented here. One can recognize great diversity in size, discipline, and potential impact, but all the projects are designed ultimately to develop greater opportunities for student learning.

This publication is intended to provide basic information about these NSF-supported projects to other projects, the academic and scientific community, and the general public. It is planned to update this listing periodically. The projects are grouped under their principal discipline. Indices arranged by level of education and project director are provided at the beginning of this publication.

PROJECTS DESCRIBED IN THIS BOOKLET ARE SUPPORTED UNDER THE FOLLOWING NATIONAL SCIENCE FOUNDATION PROGRAMS:

- ALTERNATIVES IN HIGHER EDUCATION
- EXPERIMENTAL PROJECTS AND PROBLEM ASSESSMENT
- FIELD INITIATED STUDIES AND EXPERIMENTAL PROJECTS IN SCIENCE EDUCATION
- MATERIALS AND INSTRUCTION DEVELOPMENT - PRE-COLLEGE EDUCATION IN SCIENCE
- SCIENCE AND ENGINEERING TECHNICIAN EDUCATION PROGRAM
- SPECIAL PROJECTS
- TECHNOLOGICAL INNOVATION IN EDUCATION

Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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ARCHITECTURE AND ENGINEERING

Hartkopf, V.

ART CONSERVATION (CHEMISTRY)

Sparks, P. G.

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Davidoff, M.
Sundaram, S.

BEHAVIORAL SCIENCE

Katz, M. R.

BIOLOGY

Bishop, H. L.
Bodman, C. G.
Craig, W. H.
Dodge, R. A.
Laetsch, W. M.
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CHEMISTRY

Cole, T. W., Jr.
Hill, B.
Nelson, D. A.
Osteryoung, R. A.
Passer, M.
Pearce, E. M.
Pierotti, R. A.
Renfrew, M. M.
Roberts, T. D.

COMPUTER SCIENCE

Austing, R. H., Engel, G. L.
Bitzer, D. L.
Tontsch, J.

CONTINUING EDUCATION

Evans, L. B., Tribus, M.
McNeill, P. R.
Morris, A. J.
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EARTH SCIENCES

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Stoever, E. C.

ECONOMICS

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ENGINEERING

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Evans, L. B., Tribus, M.
Henley, E. J., Heenan, W. A.
Hoelzeman, R. G., Cain, J. T., Sze, T. W.
Jarvis, J. J.
Jensen, A. P.
Juster, A.
Kummler, R. H.
LeBold, W. K., Bond, A. J.
Lee, G. C.
McNeill, P. R.
McNeill, P. R.
Moodie, C. L.
Munushian, J.
Parsonson, P. S.
Sjogren, D.
Theodore, L.
Torda, T. P.
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Vesilind, P. A.
Volz, R. A.

ENTOMOLOGY

Tiptin, V. J.

ENVIRONMENTAL SCIENCE

Lee, A. E.
Rowe, D. R.

GEOGRAPHY

Lounsbury, J. F.
Pattison, W. D.

GEOLOGY

Bedford, J. P.
Birnie, R. W.

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Banaugh, R. P.
Bare, J. K.
Becker, P. M., Weinsohn, R. J.
Bork, A., Ballard, R., Marasco, J.
Bowers, R.
Burkman, E.
Duggan, J. L.
Dwyer, T. A.
Hamblen, J. W.
Hughes, L. A.
Johnson, J. W.
Kobelin, J.
Kozma, R. B.
Lomon, E. L.
Lopez, G. J., Miller, M.
Lucas, W. F., Luce, R. D.
Luehrmann, A. W., Jr.
Mayer, W. V.
Miller, N. H.
Nadler, G.
Novick, M. R.
Pierotti, R. A.
Pimentel, D.
Reif, F.
Shann, M. H.
Speed, R. C.
Stern, J. A.
Weindling, J. I.
Weinstock, H.
Wolf, L. J. Mowery, D. R.

INTERNATIONAL RELATIONS

Coplin, W. D.

MATERIALS SCIENCE

Andresen, S. G.
McKinstry, H. A.
Roy, R.

MATHEMATICS

Andree, R. V.
Aucoin, C. V.
Botts, T. A.
Boyce, W. E., DiPrima, R. C.
Bushaw, D.
Bushaw, D.
Bushaw, D.
Bushaw, D.
Esty, E.
Fehr, H. F.
Hoffer, A. R.
Kirchner, R. B.
LeBlanc, J. F.
Lucas, W. F., Luce, R. D.
McKelvey, R.
Max, N. L.
Nichols, E. D.
Osborne, A.
Steffe, L. P.
Suydam, M. N.
Usiskin, Z. P.
Walton, W. U.
Walton, W. U.
Whitney, H.
Wirszup, I.

METALLURGY

Twidwell, L. G.

MINORITIES - EXPERIMENTAL PROJECT

Doby, W. C.
Korotkin, A. L.
Partee-Scott, G.

NAVAL ARCHITECTURE

Woodward, J. B.

OPERATIONS RESEARCH

Jarvis, J. J.

PEST MANAGEMENT

Armstrong, D. L.

PHYSICS

Devons, S.
DiLavore, P.
Eather, R. H.
Edge, R. D.
Fuller, R. G.
Fuller, R. G.
Haber-Schaim, U.
Lieber, M.
Phillips, M.
Stannard, C. R., Marsh, B. B.
Taylor, E. F.

POLITICAL SCIENCE

Mann, S. K.
Mehlinger, H. D.

PSYCHOLOGY

Bare, J. K.
McLaughlin, D. H.

REMOTE SENSING

Mausel, P. W.

SOCIAL SCIENCE

Handler, P.
Harf, J. E.
Miller, N. H.
Morrissett, I.
Nehnevajsa, J.

STATISTICS

Dempster, A. P., Ho, Y. C.

TECHNOLOGY

Chapman, G. L.
Haberstroh, R. A.
O'Gwin, J. R.
Woolf, K.

TRANSPORTATION

Foa, J. V.
Romualdi, J. P.

URBAN PLANNING

Crum, R. G.

PRE-COLLEGE

Andree, R. V.
Bare, J. K.
Burkman, E.
Bushaw, D.
Dwyer, T. A.
Esty, E.
Fehr, H. F.
Hoffer, A. R.
Hughes, L. A.
Korotkin, A. L.
LeBlanc, J. F.
Lomon, E. L.
Lopez, G. J., Miller, M.
Mayer, W. V.
Mehlinger, H. D.
Morrissett, I.
Nichols, E. D.
Steffe, L. P.
Stoever, E. C.
Usiskin, Z. P.
Vassallo, T. P.
Wentworth, D. R., Hansen, W. L.
Whitney, H.

UNDERGRADUATE

Allan, J. J., Lagowski, J. J.
Armstrong, D. L.
Asch, T.
Becker, P. M., Heinsohn, R. J.
Bedford, J. P.
Birnie, R. W.
Bishop, H. L.
Bodman, C. G.
Bork, A., Ballard, R., Marasco, J.
Botts, T. A.
Bowers, R.
Coplin, W. D.
Davidoff, M.
Devons, S.
DiLavore, P.
Dodge, R. A.
Duggan, J. L.
Edge, R. D.
Evans, L. B., Tribus, M.
Fuller, R. G.
Haber-Schaim, U.
Haberstroh, R. A.
Hamblen, J. W.
Harf, J. E.
Henley, E. J., Heenan, W. A.
Hill, B.
Hoelzeman, R. G., Cain, J. T., Sze, T. W.
Jensen, A. P.
Johnson, J. W.
Juster, A.
Katz, M. R.
Kirchner, R. B.
Kobelin, J.
Kummler, R. H.
Laetsch, W. M.
LeBold, W. K., Bond, A. J.
Lee, A. E.
Lee, G. C.
Lieber, M.
Lounsbury, J. F.
Lucas, W. F., Luce, R. D.
Luehrmann, A. W., Jr.
McKinstry, H. A.
McNeill, P. R.
Mann, S. K.
Max, N. L.
Mayer, W. V., Postlethwait, S. N.
Miller, N. N.
Nelson, D. A.
Osborne, A.
Phillips, M.
Renfrew, M. M.
Roberts, T. D.
Speed, R. C.
Stannard, C. R., Marsh, B. B.
Theodore, L.
Tipton, V. J.
Tontsch, J.
Torda, T. P.
Twidwell, L. G.
Vesilind, P. A.
Volz, R. A.
Walton, W. U.
Weinstock, H.
Wolf, L. J., Mowery, D. R.
Woodward, J. B.
Woolf, K.

GRADUATE

Andresen, S. G.
Aucoin, C. V.
Boyce, W. E., DiPrima, R. C.
Bushaw, D.
Cole, T. W., Jr.
Dempster, A. P., Ho, Y. C.
Evans, L. B., Tribus, M.
Foa, J. V.
Hartkopf, V.
Kozma, R. B.
McKelvey, R.
McNeill, P. R.
Mausel, P. W.
Munushian, J.
Nadler, G.
Nehnevajsa, J.
Novick, M. R.
Osteryoung, R. A.
Parsonson, P. S.
Pattison, W. D.
Pierotti, R. A.
Pimentel, D.
Reif, F.
Romualdi, J. P.
Shapiro, P.
Sjogren, D.
Sparks, P. G.
Weindling, J. I.

MULTI-LEVEL

Austing, R. H., Engel, G. L.
Banaugh, R. P.
Bitzer, D. L.
Eather, R. H.
Eckhoff, N. D.
Handler, P.
Moodie, C. L.
Partee-Scott, G.
Pearce, E. M.
Rowe, D. R.
Roy, R.
Sundaram, S.
Taylor, E. F.
Tinker, R. F.

OTHER

Chapman, G. L.
Craig, W. H.
Crum, R. G.
Doby, W. C.
Jarvis, J. J.
McLaughlin, D. H.
Morris, A. J.
O'Gwin, J. R.
Passer, M.
Shann, M. H.
Stern, J. A.
Suydam, M. N.
Wirszup, I.

✓ PROJECT NUMBER: SED71-04398

PROJECT TITLE: A PROJECT TO FILM THE YANOMAMO INDIANS OF
SOUTHERN VENEZUELA FOR ANTHROPOLOGICAL
TEACHING AND RESEARCH

PROJECT DIRECTORS: Timothy Asch, Department of Anthropology
Harvard University
Napoleon Chagnon, Department of Anthropology
The Pennsylvania State University

PROJECT ADDRESS: Documentary Educational Resources
24 Dane Street
Somerville, Massachusetts 02143
(617) 666-1750

PURPOSE:

The study has had both educational and scientific objectives. Written ethnographic descriptions augmented by the documentary media of sound-synchronous film with a minimum of narration, sound recordings and still photographs, will enable students to witness importent and widespread social forms in an isolated society. There have been few opportunities to integrate film with other course materials -- the cost is too high and few films have been completed and/or distributed in relation to anthropological field research. The project was compiled from extensive research on the Yanomamo gardeners of Southern Venezuela and is juxtaposed with film and ethnography of the hunting and gathering Kung Bushmen of South West Africa and we hope soon with other cultures.

AUDIENCE:

Our films and materials are being distributed to approximately 5,000 junior colleges and universities throughout the country for use in such varied disciplines as:

Anthropology
Sociology
Psychology
History
Art
Music
Folklore
English
Political Science
Comparative Law
Medicine

We are now planning to devise a curriculum for potential use in high schools.

INNOVATIONS:

The in-depth source materials allow professors the most flexible resource for teaching social sciences at the high school and college levels. Our film-based resource portrays specific events in Yanomamo society. The films are short, and will be accompanied by film notes. Teachers can use these films as separate units or in combinations chosen by the teacher to focus on one topic. They can be effectively used in conjunction with !Kung Bushmen film materials, for which in-depth written study guides are available. Thus teachers don't have to order an hour long film in order to show 10 minuted related to a specific topic they might want to teach. If, for instance, they are interested in shamanism, there are now seven films on the subject available that can be used in any creative combination a teacher might devise. If they are interested in leadership in a basically egalitarian society such as the Yanomamo, they could select from 5 film sequences which show a Yanomamo leader and shaman in different social contexts. The Yanomamo films have been in popular academic distribution since 1971.

EVALUATION:

We have a very indirect evaluation system. However, many of our final films are the direct outgrowth of a teaching situation. As such, some of the films first produced in the inexpensive work print optical form which we have developed for this program, have gone through as many as 20 revisions before finally being released to the public. The distribution of these films has steadily increased since the first films were released in 1971. We perceive this increase in use in the educational market as a positive evaluation. In addition, several of our films have won many film awards; two of them several international awards, and one has won first prize in every festival it has ever been entered in.

MATERIALS:

Through the initial success of this project, we were able to generate supplemental funds so that there are now 21 Yanomamo film sequences and accompanying film notes in distribution. We will be developing more extensive written materials to supplement each film shortly. This filming project is an outgrowth of anthropological research done by Napoleon Chagnon over an 11 year period and as such there are two books and numerous articles which can be used in relation to the films for teaching. Indeed one of the most intimate relationships between ethnographic filming and published ethnographic material can be seen in Chagnon's 1974 book Studying the Yanomamo, several appendices of which relate the films directly to the ethnographic material. Currently we are trying to generate support for a high school curriculum using these and other ethnographic film materials. The materials comprising this project are distributed by: Documentary Educational Resources. The films are also available from the Pennsylvania State University, Psychological Cinema Register, University Park, Pa. 16802.

PROBLEMS:

Our most critical problem is in working with what can now, in 1977, only be evaluated as a dinosaur technology. We feel as soon as a video cassette or record is available to the general public that we will have widely distributable educational materials.

FILMS PRODUCED BY THIS PROJECT AND AS AN OUTGROWTH OF IT:
(The first two films were produced on a previous grant by the Atomic Energy Commission.)

THE FEAST (30 minutes) 1968.
YANOMAMO: A MULTIDISCIPLINARY STUDY IN HUMAN GENETICS (45 minutes) 1968.
MAGICAL DEATH (30 minutes) 1971.
A MAN CALLED "BEE": STUDYING THE YANOMAMO (40 minutes) 1971.
OCAMO IS MY TOWN (23 minutes) 1971.
ARROWS (10 minutes) 1971.
WEEDING THE GARDEN (14 minutes) 1971
A FATHER WASHES HIS CHILDREN (15 minutes) 1971
FIREWOOD (10 minutes) 1971.
A MAN A HIS WIFE WEAVE A HAMMOCK (12 minutes) 1971.
CHILDREN'S MAGICAL DEATH (7 minutes) 1971.
CLIMBING THE PEACH PALM (9 minutes) 1971.
NEW TRIBES MISSION (12 minutes) 1971.
THE AX FIGHT (30 minutes) 1971.
TAPIR DISTRIBUTION (15 minutes) 1971.
TUG OF WAR (9 minutes) 1971.
BRIDE SERVICE (10 minutes) 1971.
YANOMAMO MYTH OF NARO AS TOLD BY KAOBAWA (22 minutes) 1971.
YANOMAMO MYTH OF NARO AS TOLD BY DEDEHEIWA (22 minutes) 1971.
MOONBLOOD: A YANOMAMO CREATION MYTH AS TOLD BY DEDEHEIWA (14 minutes) 1971.
JAGUAR: A YANOMAMO TWIN CYCLE MYTH AS TOLD BY DARAMASIWA. Part I (22 minutes) 1971.

February 1977

Architecture
Civil Engineering
Management

PROJECT NUMBER: SED 74-23282 **AMOUNT AWARDED:** $457,430

DATE AWARDED: April 1, 1975 **DURATION:** 40 months

PROJECT TITLE: INTERDISCIPLINARY MASTER'S PROGRAM IN BUILDING STUDIES

PROJECT DIRECTOR: Volker Hartkopf, Associate Professor of Architecture

PROJECT ADDRESS:
Advanced Building Studies Program
Carnegie-Mellon University
5000 Forbes Avenue
Pittsburgh, Pennsylvania 15213
Telephone: (412) 621-2600: ext 8889, 8708

PURPOSE:

Advanced Building Studies is an interdisciplinary graduate program sponsored by the department of Architecture, Civil Engineering, and the School of Urban and Public Affairs. It was developed to respond to challenges confronting the breadth of professions engaged in making and changing the built environment. The objective of the program is to provide advanced training of persons who can constructively engage in the planning, design, construction and operation of the built environment, by considering the interrelated aesthetic, technological, financial and managerial aspects of building problems, embedded in a systems approach. The program integrates methods, knowledge and techniques which address problems of building simultaneously instead of following traditionally fragmented approaches to environmental problems.

Challenges.

Product Challenge. The development of new knowledge concerned with product properties and their relationship to performance is needed. The physical environment must provide users with a wide and expanding set of services. Privacy, security, diversity, identity, opportunities for contact and access, are among the important properties of every environment. In the future all components of the built environment must be designed with such considerations explicitly identified. Before these considerations can be consistently applied, new bodies of knowledge and related methodologies must be developed.

Process Challenge: The processes producing changes in the built environment must be constantly broadened to include consideration of constraints, objectives and interrelationships previously unrecognized. More comprehensive models of the physical environment must be developed for planning, design and operation. The increase in materials costs and depletion of natural resources all require consideration in building design and operation. External as well as internal considerations must also be included. For instance it is no longer permissible to design built environments which dispose of their wastes or pollutants at the expense of the general community.

Organization Challenge. The organization and operation of the professions dealing with the built environment is rapidly changing. The present fragmented patterns are giving way to integrated team design, construction-management-operation concepts, and accelerated design-construction processes. Team approaches must be flexible enough to make use of all individuals and disciplines represented. These approaches will have to result in new answers to the integration of goals, objectives, tools and techniques. The increase in building industrialization and governmental regulatory activity has created new contexts requiring more explicit problem solving behavior and intra-professional understanding.

The challenges discussed require a new approach to professional education for those involved with the built environment. The future design professionals are still predominantly prepared in narrowly defined "professional" schools of architecture, engineering or management, which coexist on campuses without any significant cooperation between faculty and/or students.

AUDIENCE:

The Advanced Building Studies Program addresses the training needs of architects and engineers with first professional degrees as well as professionals with management backgrounds. The program prepares them for leading roles which are emerging in response to the desribed product, process and/or organizational challenges Such roles require a synthesis of traditional disciplinary knowledge, an overview of building problems and solutions, and effective multidisciplinary teamwork.

It is expected that the new knowledge, methods and techniques applied in leading institutions will influence the practice of all professions addressing problems of built environments. Currently the architecture and engineering community alone consists of over 100,000 members.

The future professionals will develop solutions to problems in built environments resulting in an increased efficiency of the use of scarce resources, such as energy and finances as well as resulting in environments which are more responsive to the needs of the users such as privacy, security, diversity and community Therefore, the Nation on all levels will benefit directly and indirectly by this new program.

INNOVATION:

The Advanced Building Studies Program combines the efforts of the Departments of Architecture, Civil Engineering and the School of Urban and Public Affairs in teaching courses, and conducting projects both multidisciplinary in nature. The student body consists of architects, engineers and managers. Graduates will be uniquely prepared for positions in large architectural and engineering firms, construction firms, real property development and management organizations, mortgage lenders and other property investors, manufacturing organizations which concern themselves with building related products, local, state and national government agencies concerned with regulation of the built environment.

The program aims at achieving relevance by addressing problems of national importance and by involving leading practitioners, researchers and educators covering specialty areas.

EVALUATION:

The program is being guided and evaluated on four levels. On the first, a steering committee consisting of six key faculty and administrative members guides the policies and overall direction. In the second, a group of ten leading practitioners from the building industry provides important links to the professions. On the third, a national advisory committee is being formed consisting of five members who shape new directions in practice research and teaching. And finally, the research conducted and supported by grants provides another important measure of success of the program.

MATERIALS:

The program is in its second year of operation. During 1975-76 twelve new interdisciplinary courses, including three project courses, have been offered. At the end of the present year (1976/77) four new courses (including 3 projects) will have been offered out of a total of 10 courses taught. Four of those courses will be available in module form for distribution at the end of the contract period.

The material will consist of lecture notes, exercises, slides and other material which lends itself to self-paced learning covering four of the following five areas:

a) Analysis, Synthesis and Optimization of Physical Systems
b) Building Appraisal and Operations
c) Methods for Computer Aided Design
d) Material Selection and Component Design
e) Structural Systems in Design

The 1975/76 project course resulted in a report which is available for distribution at cost ($10 per copy).

PROBLEMS:

A new program such as building studies must become well known to attract a substantial number of qualified students In addition, the multidisciplinary nature of ABS requires a balanced student body consisting of architects, engineers and managers. Particular difficulties arise in capturing the interest of graduates with management backgrounds.

Therefore, during 1975/76 and 1976/77 vigorous efforts are being, and have been made, to insure the cooperation of relevant segments of the building industry to sponsor the program in form of scholarships. These scholarships provide the base of financial support for qualified graduate students, as well as an important link to the building industry, which results in greater knowledge about the program

February 1977

✓ PROJECT TITLE: MASTER OF SCIENCE PROGRAM TO TRAIN ART CONSERVATORS

PROJECT DIRECTOR: Peter G. Sparks

PROJECT ADDRESS: Art Conservation Department
219 McDowell Hall
University of Delaware
Newark, Delaware 19711
(302) 738-2479

PURPOSE:

The purpose of this project is to develop a three-year educational program to train art conservators who will be competent in restoring and conserving art and cultural objects made from paper, paint, textiles, metals, glass, ceramics, stone, wood, and various ethnographic materials. The program undertakes to train on a broad basis with the goal of turning out an art conservator who understands the properties of art materials used in conservation from a scientific viewpoint and who is familiar with the physical and analytical techniques that can be utilized for characterizing these materials. It is a central theme in our program that our graduates will not only be part art historian and scientist, but expert craftsmen who can restore art objects. There is a tremendous need in the United States for conservation of its cultural and artistic heritage. Graduates of our program will help meet the demand for trained individuals to take on the challenge of preserving the art objects that are part of this heritage.

AUDIENCE:

In the United States alone, there are six thousand museums and historical societies and this number is growing yearly. Of this group, approximately sixty-five museums have in-house conservation facilities and as best as we can determine from available budgetary figures, approximately one thousand of these institutions have enough funds to be able to afford some type of conservation service. Thus, the group that would receive immediate benefit from the availability of training professionals in this area would be the museums and historical societies. It is not unreasonable, however, to make the point that the indirect benefits of this effort will be realized by the hundreds of millions of people who visit our museums now and in the future to enjoy viewing the objects displayed in them.

INNOVATION:

The unusual aspects of this educational project center around our efforts to train an individual in such a way that they develop skills in three areas, i.e., art history, material science, and craftsmanship. In addition, we are attempting to offer a broadly based training experience that allows opportunity for majoring in more areas of conservation than any other existing program. The advantages of this approach will be to put professional conservators in the field who can make sensible and intelligent decisions about techniques for proper conservation of works of art because they have a good understanding of the chemical and physical properties of art materials as well as the aesthetics of the work of art. We feel that the likelihood of success is good, however, the program is only in its third year and, therefore, although our outlook is very positive, it is difficult to measure our success in terms of graduates. We are also trying to develop written instructional material relating to applications of science to art conservation that can be utilized by other training programs in this area.

EVALUATION:

The project was evaluated in January, 1976, after two years of operation and in the future will be evaluated every three years by an outside committee composed of leading educators, art conservators, and scientists. The Committee's recommendations have been used to improve the quality of the program. Student evaluation and feedback is encouraged and we get this type of information each semester on all course material.

MATERIALS:

When fully developed, the program will make available to the museum field well educated professional art conservators. In addition, instructional material will be made available through the Program Director to other training programs.

PROBLEMS:

The most serious problem encountered so far has been to identify and hire well qualified faculty to teach various areas of art restoration. During the past year, we have managed to hire two new faculty to complete our staff and are on the way to developing a strong conservation faculty.

18 February, 1977

Astronomy
Electrical Engineering
Electronics Technology
Mathematics
Physics

✓ **PROJECT NUMBER:** SED75-17333; **AMOUNT AWARDED:** $34,400.

DATE AWARDED: July, 1975; **DURATION:** 27 months

PROJECT TITLE: USING SATELLITES IN SCIENCE, ENGINEERING AND TECHNICAL EDUCATION PROGRAMS

PROJECT DIRECTOR: Martin Davidoff

PROJECT ADDRESS: Catonsville Community College
Catonsville, Md. 21228
301-4554378

PURPOSE:

Several active satellites currently in orbit are suitable for "live" classroom demonstrations and student laboratory exercises. These satellites are available without charge to educators in astronomy, electrical engineering, electronics technology, mathematics, physics, and other fields. The objectives of this project include introducing educators to these satellites and providing educators with the information needed to use satellites in educational programs. Instructors will find that satellites are useful for presenting normal course content and/or introducing material on space science into their curricula. Note that this is *not* instructional TV or radio via satellite. It is the use of a new and exciting tool for science education -- multi-million dollar satellites are directly available to every instructor and to every student at his/her laboratory workbench.

AUDIENCE:

The immediate audience for this project consists of educators working with undergraduate students in astronomy, electrical engineering, electronics technology, mathematics and physics. The materials produced by this project will be of interest to (1) instructors involved in planning lectures, demonstrations, regularly scheduled laboratories and open-ended project laboratories, (2) individuals involved in curriculum development projects and (3) textbook authors. To bring this project to the attention of this audience, (1) demonstrations of satellite communications using a specially developed portable ground station have been given at national conferences (American Physical Society - American Association of Physics Teachers, Feb., 1976; American Society for Engineering Education, June, 1976) and regional conferences, and (2) articles describing aspects of the project have appeared in science education journals (American Journal of Physics, Vol. 44, no. 3, March 1976; Engineering Education, Vol. 67, no. 8, May 1977).

INNOVATION:

Introducing work with satellites into a science course requires (1) a satellite which can be used with simple ground station equipment and (2) reference material for the instructor including information on satellite systems, ground station assembly, and suitable experiments. The satellites have been provided by AMSAT (Radio Amateur Satellite Corporation) and launched by NASA. This project provides the reference material.

Satellites. For a number of technical and operational reasons most commercial and scientific satellites are poorly suited to the needs of educators: They usually require complicated ground station equipment and their operating schedules are frequently incompatible with educational requirements. To remedy this situation a series of non-commercial satellites designed to facilitate educational use are being constructed. Two satellites in this series, AMSAT-OSCAR 6 and AMSAT-OSCAR 7, are currently in orbit and active; and AMSAT-OSCAR 8 is scheduled for a late 1977 launch. The AMSAT-OSCAR satellites have been designed so that they can be used in conjunction with simple, inexpensive ground stations. Many educators are still unaware of the availability of these satellites.

Reference material. Before the inception of this project, data on the AMSAT-OSCAR satellites could only be obtained by searching through the literature in a number of fields. In addition, information on assembling a ground station for educational purposes and on suggested experiments was sketchy or non-existent. As a consequence, educators desiring to use the AMSAT-OSCAR satellites had to develop their own programs almost entirely from scratch. The amount of work involved was often prohibitive and the duplication of effort was a great waste of personpower.

This project will alleviate the problems discussed above. A text is being written to provide educators with complete information for initiating programs using satellites. The availability and utility of the AMSAT-OSCAR satellites will be publicized through journal articles and by giving demonstrations at educational conferences using a small portable ground station.

EVALUATION:

An advisory committee consisting of educators and senior level scientists from industry and government -- all directly involved in satellite communications -- has been formed to provide guidance and to review project materials for accuracy at all stages of development. In addition, laboratory exercises and demonstrations are currently being class-tested at a number of educational institutions by interested educators.

MATERIALS:

The text being written is a practical and informal introduction to satellite systems; it is *not* a scientific treatise. It presents (1) background material on satellite systems, (2) complete information on ground station assembly, (3) examples of student laboratory exercises and classroom demonstrations, and (4) a bibliography. The text includes a number of self-contained sections which can be assigned to students as supplementary readings. Since each department has different educational objectives and different equipment available, the text is designed to enable instructors to formulate student laboratory experiments and/or demonstrations which complement their curriculum objectives and which, when possible, use equipment already on hand. Title and chapter headings from a Preliminary Edition of the text (311 pp.) published in Sept. 1976 follow:

USING SATELLITES IN THE CLASSROOM:

A GUIDE FOR SCIENCE EDUCATORS

I. Earth Satellites: Orbits and Tracking
II. Tracking AMSAT-OSCAR 6 and 7
III. Satellite Systems: Emphasis on AMSAT-OSCARs
IV. Ground Station Equipment
V. Educational Experiments and Activities

In addition to the text, a simple portable ground station, which fits in a small suitcase, has been assembled for this project.

PROBLEMS:

Two significant problems have been encountered in the course of the project. First, the amount of time needed for information dissemination (conference attendance, correspondence, text distribution, article preparation, etc.) and administration (overseeing text production, developing administration procedures, etc.) was seriously underestimated. This problem was somewhat alleviated by a supplemental grant which enabled the project director to devote full time to the project during the summer of 1976. Second, procedures for text distribution have not yet been finalized. The potential distribution, 2,000-5,000 copies, doesn't justify commercial investment. And, logistical problems make distribution of this many copies by the project director's institution impractical. Distribution by the Government Printing Office would be an excellent solution and an attempt is being made to see if this can be arranged.

FEBRUARY 1977

PROJECT NUMBER: SED 75-21297 AMOUNT AWARDED: $34, 000

DATE AWARDED: June, 1975 DURATION: 19 months

PROJECT TITLE: MINICOURSES IN ASTROPHYSICS: MODULAR APPROACH

PROJECT DIRECTOR: S. Sundaram

PROJECT ADDRESS: University of Illinois at Chicago Circle
Chicago, Illinois 60680
Phone No. (312)-996-3400

PURPOSE:

The project is aimed towards developing a series of minicourses in Astrophysics with text materials for students and teachers of advanced undergraduate as well as beginning graduate classes in sciences and engineering. The set of minicourses will consist of several modular units with each unit presenting some important aspect of recent exciting developments in astrophysics. It is also the purpose of this project to put together sequences of related minicourses or modules with a common theme in most cases to form unified courses.

AUDIENCE:

The minicourses (modules) are intended for advanced undergraduates and first year graduate students in sciences and engineering. While a background in introductory quantum mechanics and electrodynamics beyond general physics sequence is required for optimum results, the modules can be used for non-science majors with relatively simple modifications. For the non-science majors a general descriptive course can also be planned with the help of the modules omitting mathematical derivations and some of the details. The modules would fit the essential needs of physicists, astronomers, and even engineering faculty assigned to teach astrophysics in colleges and universities in response to student demand for such courses.

INNOVATION:

The most important innovative feature of this project is that each minicourse or module will cover in a compact and more or less independent way some topic or small area of modern astrophysics. The units are designed such that they are of no particular, standardized length but average perhaps three to five weeks of instruction depending on the teacher and the audience and therefore ideal for easy adaptation to the standard school term requirements (quarter or semester or school year).

Another equally important innovative feature of these modules is that suitable modules and related sequences of modules with a common theme can be used in conjunction with regular astronomy or physics or chemistry or engineering courses to expose the advanced undergraduates and beginning graduates to special topics built on their background in their basic courses. Thus faculty in physics, astronomy, and other sciences as well as engineering would find it useful in their offerings especially since each module will be a compact "minitext" of an interdisciplinary nature offering a rare degree of flexibility in teaching.

EVALUATION:

The topics for the modules were arrived at following a Faculty Workshop in Astrophysics conducted with NSF support at Chicago Circle during Summer 1974. The participants at this Workshop were leading astrophysicsts from several universities across the country. To be of maximum use to the audience which this project is intended for and to the teachers who will be using these modules in their course offerings, it is planned to have these modules evaluated by a select group of astrophysicists. These evaluators will be chosen mostly from the participants of the above-mentioned Workshops or those actively engaged in teaching astrophysics courses to the undergraduates. At the end of this academic year along with copies of the modules an appropriate questionnaire will be mailed to a select group of about 12 evaluators from the groups mentioned earlier. The responses from such evaluations will be reviewed and suitable modifications will be incorporated in the form of either revised editions of the modules or addenda to the modules. These will be available in a published form at the end of the next academic year. Also, during the progress of the project, some of the modules are being used in courses (by the project associate at Florida Institute of Technology) to evaluate their usefulness to the undergraduates.

MATERIALS:

At the completion of the project, it is hoped to have 15 to 20 modules available in the form of minitexts with suggestions regarding use and adaptation in existing courses or curricula.

Further, these modules will have references for those interested in detailed study and/or further development of the topic to suit special needs. These texts will be distributed to a selected number of teachers for evaluation purposes and others interested in using them can get copies through the project director. Examples of topics to be covered in the modules are High Energy Astrophysics, Radio Astronomy, Planetary Atmospheres, Stellar Structure and Evolution, Molecular Astrophysics, etc.

PROBLEMS:

Much of the material to be included in the planned modular units being contemporary, there exist no suitable texts or single sources from which the framework for each topic can be designed. Some of the material is widely dispersed in the literature, over a number of texts, reviews, and references. Hence, there has been some delay in progress in respect of certain topics particularly those which cannot be discussed in great depth without special backgrounds for the students. There has not been adequate time to evaluate each module during this academic year by teachers other than the project personnel as we had hoped originally at the beginning of the project.

ADDITIONAL COMMENTS:

As mentioned in our report last year, for the results of the project to provide the maximum usefulness to the teaching of astrophysics to the undergraduates, a "follow-up" conference and workshop will be essential. Such a conference can be effectively used to discuss (i) the impact of the modular form and (ii) formulation of sequences of interdisciplinary topics as well as non-traditional approaches of teaching them. With ever-increasing demand from students for Astronomy and Astrophysics courses physicists, engineers, and others on the university faculties who had no formal training in astrophysics are called upon to teach the above courses. These teachers would definitely welcome suggestions that a "follow-up" workshop may provide to incorporate the topics and sequences in regularly scheduled courses.

The project director is planning to provide a limited number of copies of the modules at no cost to faculty members who will be prospective users at colleges and universities. For obvious reasons of cost of production, volume of sales, frequency of use etc., the commercial publishers are generally less interested in producing such modules. As such if there is a large number of requests for the project materials, we have to seek a small additional support from NSF for reproducing them and making them available to the interested users.

February 1977

✓ **PROJECT NUMBER:** SED-74-08971 **AMOUNT AWARDED:** $724,300

DATE AWARDED: 6/24/74 **DURATION:** 36 MONTHS from 6/1/74

PROJECT TITLE: SIGI: CONTINUATION OF DEVELOPMENT, FIELD TEST, AND RESEARCH

PROJECT DIRECTOR: Martin R. Katz

PROJECT ADDRESS: Educational Testing Service
Princeton, New Jersey 08540
609-921-9000

PURPOSE:

A major purpose of the System of Interactive Guidance and Information (SIGI) is to help college students make informed and rational career decisions. It aims to increase their freedom of choice, to develop their understanding of the elements involved in choice, and to improve their competence in the process of decision-making. Students using this guidance system interact with a computer in such a way as to examine their values, obtain and use relevant information, interpret predictive data, and formulate plans.

AUDIENCE:

Users of SIGI are mainly students in two-year and four-year colleges, or people expecting to enter institutions at which the system is available. It is hoped that a large number of colleges will install SIGI.

INNOVATION:

SIGI applies a model of decision-making in which students first explore and examine their own values; ten occupational values are defined in operational terms, and students eventually assign weights to each dimension in keeping with its importance to them. Occupational information is stored in the system in terms generally isomorphic with the values dimensions. Thus, students can retrieve lists of occupations that meet their specifications in respect to various sets of values that they select; they can also get up-to-date answers to pointed questions about such topics as work activities, entry requirements, income, personal satisfactions, and outlook for a large number of occupations. Procedures for collecting, analyzing, interpreting, maintaining, and storing occupational information have been developed and documented. Unique prediction equations are computed for assessing students' chances of success in "key courses" for a wide variety of programs at each college; predictor variables include not only such conventional indices as previous performance and test scores, but also sets of self-ratings based on extensive information about the criterion (i.e., factors related to success in each course). Thus, students are not merely passive recipients of predictions--they participate actively in the process of generating probability statements. Students are enabled to scrutinize plans for entering occupations of their choice; they can judge whether they are willing and able to meet the requirements for entry, can choose between alternative paths, and can work out a step-by-step program. Finally, they learn a strategy for pulling together all these components in a process of rational and informed decision-making; they learn and use "decision rules" that take into account both the relative desirability of the occupations being considered and the relative probability of success in preparation for entry. Many of these concepts cut across disciplines in the social sciences, representing development and application of decision theory and information theory appropriate to psychology, sociology, and economics. In addition, SIGI explores and demonstrates new possibilities for non-numeric applications of computer science, using a mini-computer to support a highly interactive multi-terminal system that incorporates very large data bases, extensive text manipulation, and flexible storage and retrieval.

EVALUATION:

The project has been previously evaluated at various stages of development by external advisory committees, by reviewers appointed by funding agencies, and by means of a pilot study at one college (published in 1973). Field testing at six colleges is now nearing completion. Sources of data include students (structured interviews and questionnaires), counselors (questionnaires), and computer disks (records of students' interactions with the system). Data are now being analyzed, and a report will be written in spring 1977. Independent evaluation studies have also been conducted by staff members at three of the six sites and at a seventh site not included in the NSF study.

MATERIALS:

The computer program and scripts reside on disks for Digital Equipment Corporation's PDP-11 computers. Associated materials include a handbook for counselors, kits and manuals for the Prediction and Planning sub-systems, a manager's guide, a hardware configuration guide, a handbook for the occupational information, and research bulletins on the validity of the Prediction subsystem. The materials and a license to use SIGI can be obtained presently from ETS.

PROBLEMS:

One unexpected problem has been loss of a number of records of student interactions with the system at one site. Apparently, disk storage space for records was swamped by other (non SIGI) uses so that records were not properly copied in the scheduled disk sweep. A related problem involves cutbacks in college budgets during the past year, preventing some of the sites from buying additional terminals and getting them installed in time for our data collection. Both of these problems have required that data collection be extended over a longer period of time than originally scheduled in order to obtain a sufficient number of cases.

✓ PROJECT NUMBER: SED76-02877 AMOUNT AWARDED: $165,275

DATE AWARDED: June 1, 1976 DURATION: 36 months

PROJECT TITLE: TEACHING MATERIALS IN MICROBIOLOGY FOR HIGHER EDUCATION

PROJECT DIRECTOR: Helen L. Bishop

PROJECT ADDRESS: American Society for Microbiology
1913 I Street, N.W.
Washington, D.C. 20006
(202) 833-9680

PURPOSE:

The purpose of this project is to determine the need for a variety of instructional materials, particularly independent study units, that would be helpful to teachers of microbiology; to determine the types of instructional aids currently available or in the process of development; to prepare, distribute and maintain an up-to-date listing of available materials; to solicit proposals for the development of educational materials; and finally, to fund those that fulfill a need and meet the standards of quality set by the evaluating committee.

AUDIENCE:

The most immediate audience reached by these materials will be instructors of microbiology at all educational levels. The catalogue will allow the instructor a much wider selection of materials from which to choose, while the newly produced materials will fill gaps made evident by the survey of available materials.

Ultimately, it will be the biology-microbiology student who will benefit from the increased availability of teaching materials. Whether the student is in a degree program at a major college or university or in an allied health sciences program at a junior or community college, the quality of teaching should be improved by permitting teachers flexibility in designing materials to meet their specific needs. The goals of this grant are broadly structured and should prove helpful to most of the instructional objectives of microbiologists.

INNOVATION:

The identification of currently available teaching aids, the determination of the need for new instructional materials and the production of new programs is a large and complex undertaking. Such a project requires the time of individuals knowledgeable both in the areas of microbiology and in the production of multimedia programs.

INNOVATION: (Continued)

The American Society for Microbiology (ASM), through its Committee on Educational Materials of the Board of Education and Training (BET) and its staff, can provide the technical expertise, the educational sophistication and the administrative organization to carry through these projects. The major consideration for the Society is the assurance that these items developed will be of the highest quality.

EVALUATION:

Final evaluation of all materials will be conducted by a committee appointed by the Chairman of the BET and the Chairman of the Committee on Educational Materials. This Committee will consist of a chairman and at least four members who possess the necessary scientific expertise and technical ability to evaluate multimedia programs.

Prospective producers will be asked to submit a primary proposal listing among other basic items the goals of the project, a brief description or outline of the program or series, the intended media, the audience anticipated, estimated cost and the amount of time needed for production. Project directors of individual programs, which the Committee on Educational Materials has selected for further development, will be asked to complete a secondary, more detailed, proposal. These will be reviewed by the Committee on Educational Materials and a Committee of Content Specialists. These specialists will be selected on the basis of scientific expertise and multimedia production experience. These microbiology instructors will be drawn from institutions of varying size and complexity.

Those proposals selected for funding will have to undergo student evaluation, plus pre-tests and post-tests against cognitive and affective objectives. After these evaluations, necessary revisions will be made. Re-evaluation will be conducted periodically to ensure that the content is current.

MATERIALS:

It is anticipated that at the completion of this project, between 25-35 modules will be produced. The media used will range from films, slide/tape programs or videotapes, to computer-assisted instruction.

The major areas of Microbiology such as Bacteriology, Mycology, Immunology, Virology and Parasitology will be covered. Subject materials are expected to include classification, ultrastructure, pathogenesis, isolation, identification, metabolism, biosynthesis, physical and chemical control and the effect of antibiotics. Emphasis will be placed on the general areas of Agricultural Microbiology, Environmental Microbiology and Food, Dairy and Sanitation Microbiology.

PROBLEMS:

The first problem encountered was notifying individuals who were not members of ASM of the availability of funds for producing programs. Utilizing the newsletters of several scientifically related organizations and the assistance of the ASM Branch Educational Representatives, the Committee was able to reach individuals in related scientific disciplines and in institutions of varying sizes.

The first group of primary proposals over-emphasized medical microbiology, rather than covering a broad range of subjects as had been anticipated. Perhaps the Committee's initial announcements were unclear in this respect. On the other hand, this emphasis may be because those in the medical field are more acitve in the production of multimedia materials than those in the general academic fields. Project directors, when asked to submit secondary proposals, were instructed to broaden the coverage of the subject materials so that the programs might be widely used.

A third area of concern involved the media expertise of several prospective project directors. Although scientifically their proposals were considered to be of merit, their knowledge of production and cost appeared to be limited. Recommendations were made that these directors consult an appropriate specialist while developing the secondary proposal.

ADDITIONAL COMMENTS:

As compared to the problems noted above, one pleasant surprise was incurred with the cumulative tabulation of currently available multimedia programs. Approximately 250-500 programs were estimated to be available, including those directly related to Microbiology as well as others of marginal interest. The number now planned for inclusion in the catalogue is projected to be over 750 separate programs directly related to microbiology and covering all levels of instruction. It should be noted that the quality of the majority of these programs has not yet been assessed. The Committee on Educational Materials hopes to begin review of these materials in the near future.

February 4, 1977

Biology

✓ PROJECT NUMBER: SED75-19146

PROJECT TITLE: BIOLOGICAL TECHNOLOGY

PROJECT DIRECTOR: Charles E. Bodman

PROJECT ADDRESS: University of Maine at Machias
O'Brien Avenue
Machias, Maine 04654
(207) 255-3313

PURPOSE:

The prime objective of this four (4) year baccalaureate program is to provide, through formal education and practical experience, the skill and understandings necessary to identify and resolve problems that occur at the interface of industrial activity and the environment. More specifically the program is being designed to provide an in-depth understanding of living systems with particular emphasis on the tenacious as well as the vulnerable aspects of a variety of life cycles, interactions among living systems, and to develop talent for experimental design.

In addition to this basic biological background, students will be expectes to acquire a survey comprehension of business organization with emphasis on marketing procedures and problems, and to accomplish a social awareness of human needs, as derived from the environment, to include worldwide as well as local concerns.

AUDIENCE:

The program is being developed to provide interested students with a baccalaureate competence for either immediate professional job-entry or for matriculation into graduate specialties. A sampling of business leaders, municipal officers, conservationists and scientists in our local area has indicated a genuine interest in the program and many of them have accepted responsibilities as either members of the Advisory Board or as consultants.

INNOVATION:

The program is being developed to fill the gap between the pure technician and the highly specialized professional. Interdisciplinary aspects include the blending of business and social science experiences, both formal and practical, throughout a basic biological science curriculum. It is a response to an immediate need to resolve environmental-industrial conflicts where many of the specific problems have not yet been identified. With input from concerned individuals from industry, municipalities, conservationists, legal representatives and scientists, the program is to be designed to meet those specific needs which have become a worldwide concern.

New course offerings to be developed in direct relationship to the philocophy of this program are Analytical Procedure, Economic Biology, Commercial Ichthyology, Biological Illustration, and Scientific Writing. It is planned that much of the content of these courses will be developed in concert with cooperative education and internship activities to insure their practicality and relevance to industrial-environmental relationships as they exist today.

EVALUATION:

The immediate evaluation process will be through the fifteen (15) member Advisory Board composed of representatives from industry, governmental agencies both municipal and state, legal representatives and scientists. Through the COOP and internship phases of the program our students will be working either directly or indirectly with members of the Board or with consultants and will provide excellent feed-back for evaluative purposes.

MATERIALS:

It is anticipated that a complete four (4) year baccalaureate curriculum will be prepared including innovative and practical approaches to course content, organization of on-the-job training, and a job opportunity guide--the availability of materials will be announced at a later date.

PROBLEMS:

As of the first month of operation the only problem, and this did not turn out to be jamor, was the acquisition of qualified staffing as provided for in the grant. An earlier award date would have eased this, perhaps.

February 1977

PROJECT NUMBER: SED75-17477

PROJECT TITLE: DEVELOPMENT OF BIOTECHNICIAN TRAINING PROGRAM

PROJECT DIRECTOR: William H. Craig

PROJECT ADDRESS: Fullerton College
Fullerton, California 92634
Phone: (714) 871-8000

This project had two objectives: 1) to identify the specific skills at which biotechnical assistants should be competent and 2) to identify employment prospects and employers willing and able to assist in the intern on on-the-job training phase of the developing Biotechnician Training Program.

To identify the required specific skills we obtained job descriptions from a wide variety of state and federal sources, industrial directories, buyers guides, personnel officers, College District surveys, interviews, questionnaires and advisory groups. The general skills list was provided to our potential employers for selection, by them, of the skills needed by their technicians. The result is a selected "working" list of skills upon which our Biotechnician Program core curriculum is based.

To identify intern and on-the-job study sites, we contacted questionnaire respondents who indicated that they hired biological technicians. We interviewed them and obtained 15 agreements to accommodate students in working-learning circumstances. The internship program was well received in concept and content.

Forty-seven respondents employing 254 biotechnicians presently require 35 new employees. Thirty-seven respondents hire 2-year trainees. Twenty-four respondents hire 4-year graduates as well. Only 4 respondents hire 4-year graduates exclusively.

General technical preparation was preferred by 27 potential employers. Only 14 potential employers required specialized technical training for their entry level technicians. Licensing requirements for many medical technicians require 4-year degreed persons, excluding our biotechnician from employment as such, although some health centers consider using our biotechnicians in general laboratory duties.

There appears to be sufficient basis for continued development of the existing Biotechnician Program to the original computer-assisted modularized instruction concept. Phase II funding is to be sought and program enrollment expanded.

PROJECT NUMBER: SED 71-04400 AMOUNT AWARDED: $1,344,150

DATE AWARDED: June, 1971 DURATION: 60 months

PROJECT TITLE: BIOTECH

PROJECT DIRECTOR: Richard A. Dodge*

PROJECT ADDRESS: American Institute of Biological Sciences
1401 Wilson Boulevard
Arlington, Virginia 22209
(703) 527-6776

PURPOSE:

To produce individualized teaching modules which demonstrate a wide range of biologically related technical skills. The modules are task oriented and do not consider conceptual or philosophical questions and may be used in virtually any teaching situation requiring the learning of a biological skill or technique. Each module stands alone and demonstrates "how to do" a task. BIOTECH modules may be inserted into any teaching plan when and where students need to see how a task is done.

AUDIENCE:

Primarily designed for introductory biology courses and training of potential biological technicians. The modules have been used in two-year and four-year college and university classes in such courses as introductory biology, botany, zoology, and microbiology. In addition, the modules have been employed in industrial and government training and reasearch laboratories, as well as in technical institutes, high schools, and proprietary training institutions.

INNOVATION:

The modules are skill oriented, self-contained, independent units which may be incorporated singly or in groups within existing courses, programs, or training regimes. They are not designed as a curriculum, but rather, in the modular sense, are designed to "plug into" existing or newly designed programs. It is believed the instructor in the classroom, familiar with local situations, needs and resources, is the best individual to make the decision relative to curriculum design. The BIOTECH modules are intended to fit into such a curriculum, when and where needed. The modules may be sequenced into a series to facilitate the learning of biological skill groups.

*Current address:
Dean of Instruction
Cerro Coso Community College
Ridgecrest, CA 93555

EVALUATION:

Prior to development of prototype audiovisual modules, each script and storyboard was subjected to independent review and evaluation. Recommendations and suggestions were incorporated prior to filming. Prototype modules were evaluated in actual teaching situations in community colleges, four-year colleges and universities, primarily in introductory courses. They were also evaluated in government and private training programs and in advanced secondary classrooms. Each evaluation site was provided with an evaluation instrument for the users and an overall evaluation form for the training supervisor. The results of these responses were analyzed by the Human Factors Research Laboratory, Colorado State University.

MATERIALS:

Nearly 150 modules were produced consisting of film and tape media materials, as well as printed study guides. Other materials and activities such as Developer's Kit and workshops for potential module writers were also produced and developed. Six major biological areas were selected for module development:

General Laboratory Skills

Environmental Skills

Allied Health Skills

Laboratory Animal Handling Skills

Field and Museum Skills

Food Technology Skills

The standarized programs are published by Prentice Hall Media Inc., Tarrytown, NY. Preview copies are available upon request.

February 1977

PROJECT NUMBER: SED 74-21963 AMOUNT AWARDED: $108,443

DATE AWARDED: April 15, 1975 DURATION: 21 months

PROJECT TITLE: SYSTEMATIC APPROACHES TO BIOLOGICAL LABORATORY EXPLORATIONS

PROJECT DIRECTOR: Watson M. Laetsch

PROJECT ADDRESS: Project SABLE
Lawrence Hall of Science
University of California
Berkeley, California 94720
(415) 642-4193

PURPOSE:

Training in the skills of scientific investigation is of prime importance in science education. Few introductory biology courses, however, adequately prepare students in these skills. The immediate goal of this project is the development and testing of prototype units in genetics and in the scientific method emphasizing independent biological investigation. It is expected that the instructional strategies and specific materials developed for these units will assist in the development of additional units.

AUDIENCE:

The primary audience for these units is college students in introductory biology laboratories. The instructional items and teacher resource materials present sufficient information for the instructor to incorporate the units into both small and/or large laboratories in courses for both majors and nonmajors. Since the skills involved are fundamental to many areas of the life sciences and the materials highly modular in construction, these materials should also find potential application in upper division courses, and perhaps also in advanced high school programs. Our materials are constructed within the context of an overall structural model, based on relevant research; we expect them to be easily adaptable to other science disciplines, i.e., chemistry, geology, physics, etc.

INNOVATION:

Few introductory biology courses allow students to conduct independent investigations in the laboratory. Even most so-called investigative laboratories give students only background information and training in techniques; they do not attempt systematically to teach students to develop a reasonable hypothesis, to test it, or to analyze data. Our materials are specifically designed to develop student capabilities in the various aspects of scientific investigation in biology. We employ modular construction and the integrated use of various media such as written programmed instruction, audio tutorials and computer simulations. This allows easy adaptation to a wide variety of classroom environments. The computer programs have the capability of being used at a variety of levels and offer both experiment and test modes.

Time-sharing interactive computer systems are available on numerous college campuses throughout the country; however, there is a dearth of good instructional programs for students. We hope to fill this void, both through our materials themselves and through the model they provide for developing future materials.

EVALUATION:

During formative evaluation the staff observed selected students at several campuses as they worked through the materials; direct evaluation was received from students and colleagues as well. Several cycles of revision were made before the units were field tested on a larger number of students. Subject matter experts reviewed the units for content accuracy.

We chose four test sites in addition to the Berkeley campus for summative evaluation. The investigative skills taught in these units are not ones for which there are established unambiguous evaluative techniques. We worked with a professional evaluator to develop our measuring instruments. This included assessment of the students' abilities to formulate and test hypotheses for both theoretical and laboratory problems, as well as affective responses to the experience. The effectiveness of the computer component compared to materials without such a component was also tested.

MATERIALS:

The materials we have produced so far during this granting period are listed below.

Materials in Mendelian genetics

1) HEREDITY: Developing an Explanation, a written tutorial that introduces basic genetics concepts (139 pp.);
2) GENIE, a computer simulated laboratory in genetics (documentation includes annotated program listing, and instructions for program use and modification; 30 pp);
3) A student's guide to GENIE (18 pp.);
4) Problem Set in Genetics, a set of written genetics problems (38 pp);
5) Materials for an investigative laboratory in *Drosophila* genetics (20 pp.);
6) Instructor's Guide to SABLE Materials in Mendelian Genetics (5 pp.).

Materials in the scientific process

1) The Scientific Process, a written tutorial that teaches skills of observation and of hypothesis formulation and testing (20 pp.);

2) CONWAY, a computer simulated laboratory that presents data from a fictitious planet; these data serve as the basis for practice in observation and in hypothesis formulation and testing (program listing; 5 pp.).

During the prototype phase these materials are available from Project SABLE. At the end of the development period they will be put up for bid to commercial publishers.

PROBLEMS:

Transportability is the perennial problem of materials including a computer component. We are attempting to make the computer programs as flexible as possible for easy adaptation to different systems, but the present lack of a BASIC standard makes conversion a problem. We made every effort in the design and coding to produce clearly structured programs and to use the most universal features of the language.

ADDITIONAL COMMENTS:

We are encouraged by our test results, which show the effectiveness of our approach in teaching both biological concepts and scientific methodology, and we intend to continue developing additional materials through contract authors. These will include units on population genetics, evolution, regulatory processes and systems ecology.

February, 1977

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Biology

PROJECT TITLE: MINICOURSE DEVELOPMENT PROJECT

PROJECT DIRECTORS: Dr. William V. Mayer and
Dr. S. N. Postlethwait

PROJECT ADDRESS: Biological Sciences Curriculum Study (BSCS)
P. O. Box 930
Boulder, Colorado 80306
(303) 666-6558

PURPOSE:

The Minicourse Development Project engaged in the design, preparation, organization, and development of a series of minicourses that constitute the major content core of a generalized introductory collegiate biology course. The project was a joint effort of the BSCS and Purdue University.

The minicourses, 76 in number, cover the major fields of biology and present the topics in an individualized format and an inquiry pedagogical mode. They are organized into twelve content clusters.

AUDIENCE:

The minicourses are intended for undergraduates at the freshman level, specifically as an introductory college biology course. However, their design and flexibility permits a wide potential for use. For example, instructors may use minicourses as, 1) the basic instructional program in a biology course; 2) complementary study materials in higher level biology courses; and, 3) special interest materials for certain students in a conventional biology setting.

INNOVATION:

The term "minicourse" is intended to mean "small course." By dividing large units of content, i.e., biology, into smaller units, the elements of the instructional program can be grouped in a variety of ways to accommodate diverse requirements of both students and teachers.

The Minicourse Development Project affords even greater potential for flexible use and individualization by presenting the self-instructional materials in an audio-tutorial (A-T) format. The A-T system of individualized instruction, as developed at Purdue University, has been a successful instructional strategy in the freshman botany and zoology courses at Purdue.

EVALUATION:

An initial pool of A-T minicourses has been used in the freshman botany and zoology courses at Purdue University since 1969. These minicourses have undergone a number of evaluations at Purdue and other colleges that have used the Purdue-developed minicourses. Those evaluations were used by the BSCS in revising the Purdue minicourses.

Many of the 76 minicourses were originally developed at BSCS. Those units were sent to special biology content reviewers for their critical evaluation. In addition, experimental versions of all 76 minicourses were tested with students by the BSCS.

Thus, the published version of the minicourses includes evaluation feedback and input from content reviewers, students, and the BSCS staff consultants, as well as from the development team.

MATERIALS:

The collegiate biology minicourses are published by the W. B. Saunders Company, Philadelphia. Each cluster is composed of approximately six minicourse study guides bound together, but perforated to facilitate their organization according to the needs of the students and desires of the instructor.

The instructional materials for each minicourse contains a consumable study guide for each student, an instructor's manual (which includes a list of equipment and supplies, instructional considerations, objectives, answers to the exercises in the study guide, suggested evaluation items, and a tapescript), an audio tape, and other items (such as slides, filmloops, and posters) that are not readily available through biology supply houses.

PROBLEMS:

Perhaps the most difficult task of development from a pedagogical point of view was the coordination of the audio tapes with the study guides. The goal of the development team was to produce on tape an informal statement of the subject rather than a formal lecture. To write a script that involved the student and asked the right questions, that seemed to "talk with the student," required many revisions and much developer time.

Another problem that proved frustrating at times was to draw the fine line between the practical and the ideal. Many activities and original materials were excluded because they proved impractical, either from a marketing standpoint or because of instructional considerations.

February 1977

✓ PROJECT NUMBER: SED 75-19689 AMOUNT AWARDED: $311,075

DATE AWARDED: June 24, 1975 DURATION: 36 months

PROJECT TITLE: DOCTOR OF ARTS DEGREE PROGRAM IN CHEMISTRY

PROJECT DIRECTOR: Thomas W. Cole, Jr.

PROJECT ADDRESS: Chemistry Department
Atlanta University
Atlanta, GA 30314

Phone: (404) 681-0251, ext. 258

PURPOSE:

The purpose of this project is to initiate a Doctor of Arts Degree Program in Chemistry at Atlanta University. The program is designed to afford an alternative to the traditional Ph.D. degree for potential college teachers in institutions with sizeable minority group student populations. The D.A. Program parallels other doctoral programs but is oriented toward developing teaching competence in a broad subject matter area. Salient elements include a minimum of 42 semester hours of subject matter courses, an M.S. research thesis (6 hrs.), 9 hours of formal education courses, a teaching internship phase (9 hrs.) and a final dissertation (9 hrs.).

AUDIENCE:

The D.A. Degree Program is directed toward training community and junior college teachers and science division heads, chemistry teachers in small liberal arts colleges, and science coordinators in large public school systems. The impact of the program will be the training of minority chemists at the doctoral level for careers in teaching. Interest in the program is increasing. Although we have concentrated primarily on the impact this program will have in the Southeast, we have received several requests for brochures and copies of the D.A. Conference Proceedings from all parts of the United States. A more long-range effect will be the impact these teachers will have on the education on minority youth, especially in the South.

INNOVATION:

All D.A. candidates must serve at least one year as a teaching Assistant in one of the undergraduate institutions in the

Atlanta University Center. In addition, students must participate in the internship phase of the program, a progression of varied activities which build sequentially. The internship phase consists of three parts as described below:

Prelude to Internship - Primarily concerned with the chemistry curriculum in a community college and/or four year college. Preparation of goals and objectives for a course and preparation of feedback mechanisms and tests are topics covered in this course. Each student prepares a detailed outline of a course to be taught including initial evaluation, content, materials, organization, feedback, and course evaluation.

Internship I - Each student develops media materials, laboratories, and computer programs for a course in conjunction with the instructor. The Intern observes classes and discusses the class situation with the instructor and provides a critical summary paper. In addition, the intern prepares and presents one unit of two to four lectures or other class experiences during the latter portion of the course. He/she also prepares and administers a student evaluation form. This course is accompanied by a monthly seminar.

Internship II - Each intern has major responsibility for one course. This class is accompanied by a monthly seminar.

The Department of Chemistry sponsored a two-day Conference on the Assessment of the Doctor of Arts Degree Program in Chemistry in April of 1976. Administrators and Chemistry Department heads from selected undergraduate community and four-year colleges were invited to discuss the D.A. curriculum and impact of implementation of the program at Atlanta University. The general attitude of acceptance and endorsement expressed by the approximately thirty participants in this conference was encouraging. Some of the participants originally expressed negative views about the wisdom of starting a D.A. Program at Atlanta University. These views were directed primarily at the perennial question of D.A. vs. Ph.D. training for college teachers. The program became much more acceptable to these persons after extensive dialogue and complete scrutiny of every detail in the program. Indeed, all of the two-year college participants indicated they would unhesitatingly employ a D.A. graduate from Atlanta University. Criticisms emanating from the conference were minor and many recommendations offered by the participants have already been implemented.

In addition, several seminars have been held which focus on the teaching of undergraduate chemistry and educational technology; several more are planned. These are held in the evening and interested persons in the community are actively encouraged to attend.

EVALUATION:

The D.A. Degree Program is evaluated by all groups involved. Input is continuously being sought and received from faculty members and students in order to develop a strong program that addresses the needs of potential undergraduate college teachers and that can be completed in a reasonable period of time. Many suggestions have been incorporated into the curriculum and internship phase of the program.

MATERIALS:

All materials developed as part of the D.A. Program, including course outlines, media materials, laboratory experiments, computer programs, testing and feedback materials, etc., are available in limited quantity from the Project Director. One of the most exciting spin-offs of the D.A. Program is the development of new teaching techniques and instructional materials. Through extensive use of video tapes, we plan to develop curriculum materials in chemistry for undergraduate colleges and secondary schools in the Atlanta area. In addition to collaborating with chemistry teachers in the college ranks to develop these materials, we hope to move eventually to secondary schools, where the D.A. Program can have a definite impact on the teaching of youth.

PROBLEMS:

The major problem faced by this program centers around fellowship support for D.A. students. Current support is due to expire soon and new sources must be found.

February, 1977

PROJECT NUMBER: SED 75-15346 **AMOUNT AWARDED:** $ 28,620

DATE AWARDED: June, 1975 **DURATION:** 24 months

PROJECT TITLE: CHEMINDUSTRY LABORATORY --FUNDAMENTAL AND PRACTICAL EXPERIMENTS

PROJECT DIRECTOR: Brenda Hill

PROJECT ADDRESS:
Department of Chemistry
University of Georgia
Athens, Georgia 30602
Phone: (404) 542-2626

PURPOSE:

A set of teaching laboratory modules are being designed in which a variety of industrially important processess and analyses are used as a vehicle to present the fundamental chemistry typically taught in general chemistry laboratory courses. Such experiments should help familarize students with some applied chemistry of current importance. Each module will contain an introductory section in which the experiment to be performed is discussed in terms of its importance to applied chemistry. Modules will be structured so as to give students some choice in the problem(s) they will attempt to solve, or in the methods which they will use in solving problems. Such exercises should foster independence and creativity in the laboratory. Modules will be designed such that students will be required to organize data and write formal laboratory reports. Such requirements should help students learn to express themselves clearly and make them aware of the importance of such written communication in scientific laboratories.

AUDIENCE:

The experiments will be designed for use in laboratory courses in chemistry for college freshmen. The experiments may also be used to supplement the Modern Chemical Technology (Chem Tec) materials which are designed for use in training chemical technicians.

INNOVATION:

Each experiment is being developed in collaboration with a chemist who works in some area of applied chemistry. In some instances the chemist suggests the experimental design and provides background information for use in the introduction. However, some of the experiments are being researched and designed by the Chemindustry staff, and in turn critiqued by industrial chemists.

EVALUATION:

The experiments are being tested initially by individual students who work as laboratory assistants in the Department of Chemistry at the University of Georgia. All are being tested in teaching laboratories, in experimental sections of twenty students. Some of the experiments will be used as a part of the regular course work in the general chemistry program at the University. Revisions are being made on the basis of these trials and on the recommendations of consultants.

MATERIALS:

Several modules have been tested in the teaching laboratory and are near completion. Below a list of these are given in terms of the fundamental concepts illustrated by each module and the applied chemistry used to develop these concepts.

Basic Concepts	Applied Chemistry Illustrated
(1) The metric and English systems of measurement. Use of several measuring instruments including analytical balance and vernier caliper. Involves several units of measurement including measurements on a plastic synthesized as a part of the experiment.	Conversions between metric and English systems that are encountered in industry are illustrated. Organization of data and lab reports are stressed. Extensive use of handbooks required.
(2) Some practical applications of density measurements. Involves the use of several instruments and the pycnometer, hydrometer and pipet.	Measurements are made on a number of samples of raw materials and products on which density determinations are typically made in industries producing steel, paper, and agricultural chemicals.
(3) Several of the top twenty industrial chemicals are reacted or synthesized via reactions used in industry. The separations of products are performed by methods that illustrate both large scale and common laboratory separations.	Some of the processes covered include the anodizing of aluminum, and the preparation of sodium phosphates, cupric sulfate, ammonium sulfate and iodine. Principles of separation include precipitation, crystallization, filtration, sublimation, and solvent pairs.

(4) The gas laws and stoichiometry. Also the absorption of gases by solids (via chemical reaction).	Two important products, calcium nitrate and carbon dioxide, are produced quantitatively from calcium carbonate and nitric acid. The quantitative absorption of carbon dioxide by a soda lime absorbant (used in anesthesia systems) is performed.
(5) Qualitative analyses for the halogens, sulfur, and nitrogen illustrate periodic properties as well as the techniques for performing these tests. After tests on a series of knowns are performed, tests for the presence of these elements in biological and organic compounds are performed.	An adaptation of the Schöniger Oxygen Flask Combustion is used. Adapted from procedures given by the American Society for Testing and Materials and the United States Pharmacopeial Convention. Among the materials that may be analyzed are: fibers, plastics, coal, foods, cosmetics, and pharmaceuticals.
(6) Acid-Base titrations and standardization of a base. An exercise requiring two laboratory periods.	Substances which are typically analyzed via acid-base titration are used. They include citric acid (a flavoring agent and pharmaceutical), lithium carbonate (a pharmaceutical) and several brands of hairspray.
(7) Redox titrations in the analyses of some common pharmaceuticals via procedures outlined in the U.S. Pharmacopeia. Students are required to make calculations in terms of balanced redox equations as well as percent purity of samples.	Includes analyses for hydrogen peroxide (an antiseptic), iodine (an antiseptic), sodium nitrite (an antidote for cyanide poisoning), and potassium iodide (an antifungal agent and medication for bronchitis and asthma).
(8) The enthalpy of acid - ammonium hydroxide reactions and the stoichiometry of the reactions, via calorimetry, using the method of continuous variations. Each acid and the base are reacted in a styrofoam calorimeter and heat evolution is determined.	The processes represented are the production of ammonium nitrate, ammonium sulfate, and ammonium phosphate. In all three manufacturing processes, the enthalpy of reaction is of particular significance. These relationships are developed in the module.
(9) The concepts of equilibria, catalysis and Le Chatilier's Principle are illustrated via the reaction of	The equilibrium reaction studied represents the commercial process for the production of ethyl acetate. The commercial

MATERIALS (continued)

Basic Concepts	Applied Chemistry Illustrated
(9) continued ethanol and acetic acid. The reactants are refluxed until equilibrium is established. The equilibrium mixture is analyzed via acid-base titration.	methods used to obtain high yields in spite of the equilibrium are also duplicated.
(10) Kinetics and the reaction order of dyeing processes. The progress of the reaction is followed spectrophotometrically. The effects of concentration and temperature changes are studied. Reaction order is determined graphically.	Students select from among four different dye-fiber systems which include the common dyes Methylene Blue and Malachite Green, Congo Red and two Rit® dyes. The fiber dyed is either cotton muslin or a yarn containing at least 20% wool. The dyeing process utilized is an adaptation of processes used in industrial laboratories to determine dyeing rates.
(11) The importance of the solubility product constant in chemical reactions and the purification of products. One K_{sp} value is determined. The relationship between K_{sp} and the experimental yield of a product is studied. The relationship between the K_{sp} of contaminants and the purification of a solution is studied.	The commercial processes used to illustrate these concepts are the production of citric acid and lithium carbonate and the starting materials used in the production of sodium carbonate.
(12) Stoichiometry, pH dependent processes, reaction rates, separations, titration curves, and pH meter titrations are studied in an alternate method for the preparation of citric acid. The reaction mixture is analyzed via a pH meter titration. The exercise includes an activity on the titration curves for strong and weak acids.	An exercise which illustrates the importance of applied research. The citric acid preparation represents a more economical process which has been proposed as a result of research in applied chemistry. The process, which thus far has been demonstrated only on the laboratory scale, would require less reactants and result in a simplier purification procedure.

MATERIALS (continued)

(13) Electrolysis, Faraday's Laws, stoichiometry, the gas laws, and acid-base titration are involved in the study of the electrolysis of sodium chloride solution.

The electrolysis of sodium chloride solution is one of the most important processes in industrial chemistry. A model of an industrial electrolytic cell can be constructed economically from chemical apparatus and equipment available from the Edmund Scientific Company and local electronics shops. students can perform the experiment with less than 5 percent error.

Preliminary work has been completed on four additional modules: (1) Synthesis and analysis of a detergent, (2) Environmentally important separations including the removal of sulfur from iron and copper ores, (3) a complexiometric titration, (4) The chemistry behind some commercially packaged kits used for field analyses. The modules may be published. If not, they may be obtained from the project director who will make their availability known via a publication in the Journal of Chemical Education.

PROBLEMS:

Most likely, the project will not be entirely complete by June, 1977. A "no-cost' extension of the grant will be requested in which the completion deadline would be extended to December, 1977. During this time major efforts will be devoted to revisions in attempts to meet specifications of potential publishers. If it appears that no publisher will be found, the modules will be made available from the project director.

February, 1977

PROJECT NUMBER: SED74-21761 AMOUNT AWARDED: $398,800

DATE AWARDED: July 1, 1974 DURATION: 48 months

PROJECT TITLE: DEVELOPMENT OF A PROGRAM IN CHEMICAL TECHNOLOGY

PROJECT DIRECTOR: David A. Nelson

PROJECT ADDRESS: Department of Chemistry
Box 3838 University Station
University of Wyoming
Laramie, Wyoming 82071
307-766-4359

PURPOSE:

The majority of job opportunities and challenges in the chemical profession in the future will be in the applied areas such as the development of new plastics and polymers to replace vanishing natural raw materials, energy production ranging from coal conversion to solar conversion, solution of environmental problems, and even the production of synthetic foodstuffs. However, most B.S. programs in chemistry are designed primarily as preparation for academic graduate work and have placed emphasis on theory and basic principles, often with little concern for applications and basic laboratory skills. This project addresses this need for more emphasis on the applied aspects of chemistry. Its aim is to significantly increase the laboratory expertise of a chemistry major at the B.S. level. We feel this will place an individual in a more flexible position, being able to either obtain a challenging job immediately upon graduation or go on to graduate school.

Specifically, the project aims 1) to develop a four-year B.S. degree program in chemistry and chemical technology at the University of Wyoming, 2) to develop transferable two-year associate degree programs in chemical technology at the seven Wyoming community colleges, and 3) to develop associated materials in the form of experiments, lecture outlines, and audio-visual supplements. The Wyoming project is intended to serve as a model for other similar programs at both the two- and four-year level.

AUDIENCE:

This program offers an alternative to anyone seeking a professional B.S. degree in chemistry, particularly those planning to enter an industrial chemical environment, or other area of applied chemistry, immediately upon graduation, or planning to pursue certain types of advanced study. The degree will offer a good base for work in interdisciplinary fields including biochemistry, forensics, toxicology, geochemistry, as well as the economic, sociological, and legal areas of applied chemical activity. This type of degree should appeal to those who enjoy laboratory work, who get satisfaction from "hands-on" experience, who have mechanical ability, and who like to work with sophisticated instrumentation. Since the program is a full professional degree program, and meets the minimum standards established by the American Chemical Society (ACS), graduates will be well prepared for advanced study if they so choose, particularly in applied areas such as polymer chemistry, forensic chemistry, or chemistry-business management. However, the emphasis of the program is to significantly increase the technical and applied expertise of a person at the B.S. level.

INNOVATION:

Our proposed program is intended to be carried out by shifting some of the educational emphasis in the traditional B.S. degree from the theoretical aspects of chemistry to the applied aspects. Traditional lectures in general, analytical, organic, and physical chemistry are utilized, but all of the laboratories are newly developed.

Students in the program have a unique opportunity to work with up-to-date synthetic and analytical equipment. Much of the instrumentation used has been obtained over the past three years, and includes state-of-the-art capabilities in such areas as electroanalytical techniques, liquid chromatography, thin layer chromatography, and polymer characterization. Several new industrially oriented laboratory courses have been initiated. These include courses in analytical chemistry, organic and polymer synthesis, instrumental analysis, separation methods, and industrial problems. The laboratories are taught by experienced faculty members, and students can interact on a one-to-one basis. As part of the experiments the students use actual company analytical methods, technical data sheets, patents, and other literature associated with a particular product. Attention is also given to related areas such as engineering, economics, and management. Report writing, problem solving and the use of the literature available is stressed in all laboratory courses. A special seminar series emphasizes the socioeconomic aspects of the application of modern chemical technology.

A vital part of this program involves collaboration with chemical industry to obtain input in the form of experiments, procedures, and problems representing "real life" situations. We have several consultants who are working with us in one of the following areas: (1) Developing industrially related applied experiments; (2) Discussing what standard methods or company analytical methods are used, supplying associated samples, and checking student results; (3) Discussing actual industrial problems and their solutions, and suggesting problems for use in advanced courses; (4) Offering plant trips, seminars or "short courses" on applied chemical topics, and participating in advisory meetings. Industrial representatives have strongly endorsed the program for students interested in careers in industrial and applied chemistry.

The program as presently developed has 128 semester credit hours, with 52-73 in chemistry and this includes at least 20 credit hours of laboratory. Fifteen hours of humanities, fine arts, and social sciences are required. Work-study and co-op projects are available. Credits obtained in summer co-op work, if elected, can substitute for others in the program. Using a flexible system of 14 to 24 credit hours in program related electives, students can specialize in a particular area of interest, either in chemistry or an interdisciplinary area.

There is a solid core of experience in the first two years, with emphasis on analysis and instrumentation, and considerable flexibility in the last two years for a student to specialize in an area of interest. Students in the program should have "marketable" skills at any time after the first year.

Although many of the ideas and approaches we are using have been presented before in individual experiments or courses, our program appears to be the first, other than co-op programs, to offer an integrated, four year program designed to acquaint a student with many of the aspects of chemical industry and applied chemistry. We expect that graduates of this program should be able to be productive in a short period of time, be reasonably independent in the laboratory, be able to analyze problems, develop methods, trouble shoot processes, or perhaps enter sales, management or public relations.

Most two-year associate degree programs in chemical technology have been designed to train persons for direct employment upon graduation. We feel that the potential to transfer to a B.S. program might be a desirable additional feature. Thus, a student would not feel that he had entered a "terminal" program, and that if he changed his educational objectives while obtaining an associate degree or desired to return for more education after a period of employment (say up to two or three years) there would be some guarantee this could be done with little or no loss of credits already earned.

EVALUATION:

Various aspects of the program are evaluated periodically by an advisory committee consisting of representatives from the chemical industry, project directors from the community colleges, project directors from collaborating four-year schools, and several other academic consultants. The experiments being developed are being tested first by faculty and student assistants, then used in the courses at both the two- and four-year level. In some cases, experiments will be published in the Journal of Chemical Education. Within the developmental period of the grant (48 months, July 1974 - June 1978) modifications and revisions of experiments will be made based on the experience of users.

MATERIALS:

This project will develop a series of experiments and courses based on the use of standard methods and industrial analyses, or ones which relate basic principles to industrial processes, real methods of analysis, and other applied situations. To date we have developed 15 experiments for introductory laboratory operations, 20 experiments for quantitative analysis, 12 for organic synthesis, 12 for instrumental analysis, and 16 for separation methods. Other experiments planned will be used in courses in advanced synthesis, industrial problems and polymer synthesis and characterization. Courses have also been developed in the use of the computer in chemistry. Audio-visual materials have been developed to supplement certain experiments. These are slide or slide-tape programs showing spectra, typical results, descriptions of experimental setups, and explanation of use of apparatus and specific techniques. Additionally, instructional slide-tape programs will be developed covering electroanalytical methods and modern high performance liquid chromatography.

Copies of all experiments, course outlines, descriptions of audio-visual materials, lists of industrial procedures, and text and reference book lists used in the project are available from the project director.

PROBLEMS:

Some problems have developed in attempting to initiate new programs, both in terms of finances and personnel. Some compromises have been made between original goals and existing programs. Enrollment requirements related to students electing the programs may prove a problem. There have been some problems in attempting to get input from industrial consultants. Generalities are free, but there has been concern over proprietary material.

ADDITIONAL COMMENTS:

Although being developed as an integrated program at U.W., the experiments are designed to be useful separately, and portions of courses being developed could be used to supplement existing more traditional courses. The probability of other institutions developing separate four-year programs parallel to existing programs is low. What is hoped for is incorporation of some of these ideas by others as optional experiments, courses, or programs. Other cooperating four-year schools are developing alternative models. They are South Dakota State University (applied chemistry option to chemistry major), University of Lowell (chemical technology minor), University of Maine at Portland-Gorham (new applied chemistry program - none existed before), and University of Maine at Farmington (applied chemistry program - modifications of existing program). Proximity to chemical industry is desirable but not essential to incorporation of these ideas.

February 1977

PROJECT NUMBER: SED 73-10325 A02 AMOUNT AWARDED: $99,950

DATE AWARDED: April, 1973 DURATION: 52 months

PROJECT TITLE: INTENSIVE MODULAR SHORT COURSES IN CHEMISTRY

PROJECT DIRECTOR: Dr. Robert A. Osteryoung

PROJECT ADDRESS: Department of Chemistry
Colorado State University
Fort Collins, CO 80523
303-491-5391

PURPOSE:

To remedy a problem existing at the graduate level in areas outside of chemistry which have a "high content" of chemistry, we are developing a series of "short courses" in a number of areas of chemistry. These courses with high audiovisual content, are designed to meet, primarily, the needs of non-chemistry graduate students or technicians who must make use of the principles, practices and instruments associated with chemistry as a core discipline. These course modules last two weeks, with an hour of lecture or a laboratory period scheduled each day.

AUDIENCE:

While aimed primarily at non-chemistry graduate students whose background in chemistry is either weak or well in the past, the program has been found to be beneficial to both university faculty and technicians who again make use of the methodology of chemistry in carrying out their work in a non-chemical area. Another potential audience, we have realized, is non-university scientists or technicians whose work involves a high chemistry content, but whose background is poor. The audience for these modules is estimated, insofar as this university is concerned, at 100-200 non-chemistry graduate students per year, and based on our experience to date, this estimate is conservative. A very large audience for this type of activity exists at other universities, particularly in the land-grant area.

INNOVATION:

In general, chemistry departments do not make an effort to provide "service" courses for non-chemistry graduate students whose interest in chemistry may be very narrow - for instance, related to a desire to make use of a particular instrument or analytical procedure. Of course, most instruction at the undergraduate level in chemistry departments, particularly in the land-grant colleges and universities, is to non-chemistry students, since hugh numbers of students take one, and possibly two, years of chemistry. The concept itself, we feel, is innovative; providing a specialized and even limited "service" in the instructional area for non-chemistry graduate students in a variety of research areas, non-chemical in nature, which do, however, utilize a good amount of chemistry, is itself unique.

EVALUATION:

An Advisory Committee, consisting of several members of departments whose students this program is aimed at, has been established. This committee will provide us with both advice as to needs of various areas and also feedback in their perception of our success - or lack of it, as the case may be. In addition, as each module is presented, a questionnaire is answered by the students to determine if they feel a real benefit has been obtained and if such a module really meets their needs, recognizing that since these are non-required courses for graduate students who are not chemists, we probably have a pre-selected group. At this time, it appears that the number of takers we have had for the series of modules already presented and for which not much "advertising" was prepared, indicates that at least the mere offering of these modules has resulted in a positive evaluation.

MATERIALS:

Most modules have had a "slide-show" basis; books, which cover certain of the material presented in the lectures and also have prints of a large number of the slides employed, have been prepared and printed. A limited number are available from the project director; we intend to present these modules again and revise the hand-out, textual material. Modules prepared and presented to date include: Pesticide Chemistry; Water Chemistry; Ion Selective Electrodes; Atomic Absorption; Chemistry of Surfaces; Gas Chromatography; Anodic Stripping Voltammetry; Standard Methods of Water Analysis; Liquid Chromotography; Solvent Extraction; and Introduction to Electroanalytical Chemistry.

PROBLEMS:

One major problem appears to be the utter heterogeneity of the backgrounds of students taking these modules. While anticipated to some extent, it is clear that the problem is, in fact, simply not totally soluble. In addition, the amount of time required to assemble a module in a presentable fashion has proven to be much greater than initially anticipated.

ADDITIONAL COMMENTS:

This program was offered through Colorado State Conferences and Institutes during the Summer of 1976. The format was changed slightly in that three modules ($\sim$8-10 lectures, 1-2 lab periods) were offered each week for a two-week period. A fee was charged and although attendance was not as large as hoped for, this method of offering during the summer in a Continuing Education concept is reasonable. Student response has generally been very favorable; labs in particular have proven to be of great benefit.

Chemistry
Chemical Engineering

PROJECT NUMBER: SED 74-20727-A04 AMOUNT AWARDED: $839,135

DATE AWARDED: June 1, 1974 DURATION: 36 months

PROJECT TITLE: DEMONSTRATION PROJECT FOR MULTI-MEDIA USER-CONTROLLED MODES OF CONTINUING EDUCATION - PROJECT CEDS (CONTINUING EDUCATION DELIVERY SYSTEMS)

PROJECT DIRECTOR: **Moses Passer**

PROJECT ADDRESS:
Department of Educational Activities
American Chemical Society
1155 Sixteenth Street, N.W.
Washington, D.C. 20036
(202) 872-4381

PURPOSE:

The American Chemical Society will develop a model for designing, producing, evaluating, marketing, and distributing continuing education materials that are extensively supplemented with computer and audiovisual techniques. Continuing education courses will be produced in this project that will be suitable for self-paced use by individuals, as well as for group use. Complete documentation will be made available to assist other societies in initiating similar programs.

AUDIENCE:

The course materials will aid in the continuing education of practicing chemists and chemical engineers who, for a variety of reasons, find the more conventional modes of education inaccessible or inconvenient. The potential audience includes the more than 100,000 members of the ACS as well as those chemists, chemical engineers, and chemical technicians who are not members of the Society. Those members of sister societies who will benefit from the documentation and software produced by Project CEDS can be considered indirect beneficiaries of the project. Students in many academic institutions should also become indirect beneficiaries.

INNOVATION:

This project has two features which differentiate it from existing modes of continuing education. The first is the delivery system--either by computer or by a self-paced audiovisual device. Courses produced by Project CEDS will use computers to deliver instruction in the areas of data analysis and interpretation, experimental design, and synthesis. Written media will be used for general information, and the user will turn to the computer terminal only for the interactive portions of the course. Courseware will be available through a commercial computer network, with ACS as the distributor who authorizes individual access to the programs. The audiovisual approach will be used for topics in which graphics, animation, and film will contribute to the understanding of concepts. At any convenient time or location, the user of the self-paced audiovisual device--a super 8/stop-frame/audio system which requires no special training for operation--can study the course materials and control the pace to a much greater extent than is possible with television or standard film.

The second unique feature is found in the development procedure, one that requires close cooperation among: the project staff, which coordinates, administers, and reviews all aspects of production from topic selection through field testing; the author, who determines the scientific content and pedagogical approach of the material; and the production director, who designs the computer program or the audiovisual materials through which the author's ideas reach the user. This method of course preparation, although administratively complex, allows the Society to select specialists of the highest caliber regardless of location, and to retain tight control over the quality of the product.

It is expected that the courses produced under Project CEDS will be of excellent educational quality, that they will be delivered to the users in an efficient and convenient manner, that the self-pacing capabilities will allow users of widely differing backgrounds to find them useful. If, as ACS expects, this method of production also proves economically viable, these media-augmented courses will be made part of the ACS continuing education program, to be revised and expanded in line with future needs of the profession.

EVALUATION:

Evaluations will consist of pre- and post-course tests, questionnaires, and personal interviews. The courses will be evaluated by an outside contractor, with full documentation of the circumstances under which the courses were implemented, measures of learning achieved, and assessment of student satisfaction, so that other societies may know under what parameters similar programs can be expected to succeed.

MATERIALS:

Ten courses will be produced--five will be augmented by audiovisual techniques and five will be computer-augmented. The first course--"Spectrometric Identification of Organic Compounds," written by R.M. Silverstein and T. Morrill and programmed by R. Crain of the University of Kansas--is being field-tested in early 1977. Other topics include Liquid Chromatography, "Scale-up for Chemists," "Statistics for Experimental Design," and "Toxicology for Chemists." These courses will be field-tested, as part of the project.

PROBLEMS:

The most severe difficulties encountered so far have been administrative. Scheduling conferences with the many groups involved with the production, setting up the administrative apparatus, developing agreements acceptable to all groups involved in the preparation of each course--these have all consumed time in a schedule that was designed to be tight. The use of media which are unfamiliar to the authors seems to be an important reason for the difficulty in maintaining production schedules.

ADDITIONAL COMMENTS:

Topic selection and computer network selection are the subjects of separate reports. Information on these, or any other phase of the project, is available from the Project Director. Also, some new techniques are being developed for producing visual materials.

February 1977

Chemistry
Disciplines: Polymer Chemistry
Polymer Science
Polymer Engineering

PROJECT NUMBER: SED75-17981 A01 **AMOUNT AWARDED:** $127,310.00

DATE AWARDED: June 1, 1975 **DURATION:** 24 months

PROJECT TITLE: THE DEVELOPMENT OF COMPETENCY BASED MODULAR EXPERIMENTS IN POLYMER SCIENCE AND TECHNOLOGY

PROJECT DIRECTOR: Eli M. Pearce

PROJECT ADDRESS: Chemistry Department
Polytechnic Institute of New York
333 Jay St., Brooklyn, N.Y. 11201
Phone No. (212)-643-5235

PURPOSE:

The development of a competency based modular laboratory experimental course dealing with the synthesis and characterization of polymers. This is intended to train scientists and engineers in the laboratory aspects of polymers. This is an area in which relatively few academic institutions presently offer course offerings, and there is relatively little written principally as introductory instructional material, although a demonstrated need exists. Each modular experiment will be autonomous, containing the necessary information for the student to have a comprehensive understanding of the purpose, methodology, and experimentation involved in each exercize.

AUDIENCE:

The course will be directed toward senior undergraduate and/or first year graduate students in science and engineering, and also will serve as an extension course for those who have terminated their education at the bachelor's degree level. As a by-product of this program, a number of the experiments could also be easily incorporated into advanced organic chemistry and/or physical chemistry courses at these levels.

INNOVATION:

There will be 15 competency based modular experiments. Each experimental unit will be self-contained and individualized. These modules will encompass polymer laboratory techniques. Educational material of this nature has not been previously available. The major divisions of the modules will be prerequisites/suggested reading, objectives, substantive statement, experimental objectives, safety statement, apparatus and chemicals, procedure, notes, calculations, post test, extension options, and references. The goal will be to make meaningful polymer experiments conform to a time frame which will fit into a standard three hour laboratory period. An increasing desire to teach polymer science in academic institutions is anticipated, and the availability of this material in an easily usable, economic form should make for more ready acceptance.

EVALUATION:

there were 18 participants in an initial survey to determine what experiments should be included in such a course - 12 from academic institutions and presently teaching polymer courses, and 6 from polymer-related industrial research. In addition to these 18 individuals, request forms for preliminary modular materials were sent to others evidencing intrest in the materials. In all, the group comprised 52 individuals, the majority of whom requested to receive the modular materials, and mailings are being made to them. They will be asked to critically review and comment on the following aspects of each module: (1) meeting the stated objectives and goals and (2) improvements on the experimental procedures within the stated experimental time limits. in some cases, it is hoped they will utilize the modules with their own students and provide feedback. Other possible participants are welcome to communicate with us. The Polytechnic will test and utilize these materials in the course - Laboratory Methods in Polymer Chemistry. Several of the modular courses will be utilized in the course - Advanced Laboratory Techniques and in possible extension short summer courses. Several of the modules will be considered for incorporation into other organic and physical chemistry courses.

MATERIALS:

The modules will be made available in the form of a package containing the 15 experiments. Consideration will be given to the publication of these materials.

PROBLEMS:

An important area will be the publication distribution and availability of these units. Modules developed will be submitted for distribution through EMMSE (Educational Modules for Materials Science and Engineering). Publicity has been and will continue to be given via ACS and SPE presentations and publications, as well as other special symposia. Dissemination and availability will be a critical anticipated problem. The only other problem will be in taloring all of the modules to fit within the stated three hour laboratory period.

February 1977

Chemistry, Physics,
Chemical Engineering

PROJECT TITLE: SURFACE SCIENCE AND TECHNOLOGY

PROJECT DIRECTOR: Robert A. Pierotti

PROJECT ADDRESS: School of Chemistry
Georgia Institute of Technology
Atlanta, Georgia 30332
404-894-4006

PURPOSE:

This project is to develop graduate level educational programs in surface science and technology crossing several traditional disciplinary boundaries providing both course work and laboratory experience in surface chemistry, surface physics and surface technology. One objective of the program is to develop the appropriate graduate level courses and design a laboratory course containing modern surface science oriented experiments.

AUDIENCE:

The program is to provide an opportunity for first year graduate students in chemistry, physics or engineering to specialize in a currently important interdisciplinary area. The program is designed to permit the student to complete all the requirements for a masters degree in his chosen field yet to take sufficiently thorough core of courses including a full summer of laboratory course in surface science and technology.

INNOVATION:

The project is to design both lecture and laboratory courses in surface science and technology. Although the lecture courses are important, we have placed particular importance on a new course entitled Surface Science Laboratory. This course is scheduled only in the summer quarter and a student obtains 9 quarter hours of credit.

Although this course changes in detail with the particular faculty involved and the interests of the students, it is basically made up of essentially 8 to 10 experiments in surface chemistry, physics or technology. These experiments are carried out under the direct supervision of a faculty member using research instrumentation. Each experiment lasts about one week and includes approximately three hours of lecture time and eighteen hours of laboratory time. The format of this laboratory will probably change in the future (see Comments).

EVALUATION:

No formal metnod of evaluation of the program has been arranged. The faculty involved in the program are all national recognized experts in various aspects of surface science and technology and they have developed individually or in collaboration with others the courses and experiments in the program. We feel the program, as far as the development of advanced materials is concerned, must thus far be judged a success since both courses and laboratory experiments in Surface Science and Technology have been developed.

Of more direct concern is the success and construction of the graduate program in Surface Science and Technology. The number of students who have received Masters degrees in the program now stands at five and a number have completed all the requirements for a degree. A total of twelve students have completed the laboratory course while each of the lecture courses has had enrollment of from five to twenty-five students each time they have been offered.

COMMENTS:

The program as currently established requires a student take 50 quarter hours of course work including at least 32 quarter hours in the students major field. A student starting in the fall quarter can complete all of the requirements and receive a Masters degree in Chemistry, Chemical Engineering or Physics at the end of a summer quarter. This program is an academically difficult one. The students who have thus far completed the program have been among the best students currently enrolled in their departments. Since these students have usually required financial support, they have been teaching assistants carrying a full teaching load as well as an extra heavy academic load.

The problem we encounter is that the number of students capable of completing the program is too small to justify the cost of offering the laboratory each summer. There are a number of students who have expressed interest in the program and have taken all or most of the lecture courses but who felt they could not afford the time or expense of taking the summer laboratory. Consequently, we feel the only way we can maintain the SST program as an option for our students is to restructure the laboratory in order that it can be taken during the academic year. This would preclude the possibility of an individyal completing the MS program in 12 months but would at least keep the option alive. We have not decided exactly how we will handle this new laboratory but it would probably be offered as separate 3 quarter hour courses rather than our present single 9 quarter hour course.

PROJECT TITLE: COLLEGE CHEMISTRY CONSULTANTS SERVICE

PROJECT DIRECTOR: Malcolm M. Renfrew

PROJECT ADDRESS: Chemistry Department
University of Idaho
Moscow, Idaho 83843
(208) 885-6787

PURPOSE:

To provide experienced counselors to college chemistry departments which are concerned with improvements in their undergraduate courses and curriculum.

AUDIENCE:

Two-year colleges, liberal arts colleges, technical institutes and universities have made use of the Service. Although small colleges with large problems might be considered prime applicants, the clients often have included institutions of good reputation with a strong desire to become better. The knowledge that the consultant's formal recommendations will go to the administrations as well as the departments apparently inhibits applications from those who lack confidence in what they are already doing.

INNOVATION:

In appropriate situations consultants may encourage new, creative programs. The visitations more often attempt to bring benefits from proven experience elsewhere. The consultants commonly are asked to help with budget problems and must draw on administrative practices which have proved successful in other schools. Some of the consultants have built outstanding reputations as effective teachers of chemistry; others are expert in newer techniques such as computer-assisted instruction and visual aids. They attempt to meet the needs of the institutions as they recognize individual needs.

EVALUATION:

No good way to evaluate visits has been devised. The formal report of the consultant to the institution is confidential, and in early years a questionnaire to institutions failed to bring from all an estimate of benefits gained from the visit. Quite often chemistry department heads send a note spontaneously to thank us for blessings received. Recently an administration called to credit C_3S for an unusual financial gain. The consultant in this case had given inspiration plus suggestions for innovative programs which had led to some small supporting grants from industry. Newspaper publicity aroused the interest of a benefactor who visited the department and gave them $250,000 to carry on the work; then subsequently left a bequest of $2,500,000. (Not all visitations have brought such a large financial return, but many have been judged successful by the clients.)

MATERIALS:

The C_3S consultants in general do not develop materials specifically intended for the institutions visited, but we attempt to keep them supplied with materials which might prove useful, e.g., the reports assembled by Research Corporation following their conferences for new department chairmen.

PROBLEMS:

In general consultants have been well received, and only in a few cases among dozens of visitations have we become aware of awkardnesses with faculty or administration resulting from a report. With the current budget tightness, many departments are asking for more help with the consultant's travel costs than in times past. It is our conviction that some investment by the institution is desirable, but we have not declined applications from institutions unable to pay travel costs. We believe that most institutions could derive benefits from a visitation, but many who could benefit most are not willing to invite a critical review of what they have been doing.

February 1977

PROJECT NUMBER: SED 75-14376 **AMOUNT AWARDED:** $193,000

DATE AWARDED: June 1, 1975 **DURATION:** 36 months

PROJECT TITLE: DEVELOPMENT OF A MOBILE SPECTROSCOPY LABORATORY

PROJECT DIRECTOR: T. D. Roberts

PROJECT ADDRESS: The University of Arkansas
Department of Chemistry
Fayetteville, Arkansas 72701
Phone No. 501-575-4601

PURPOSE:

Because the budgets of Chemistry Departments of smaller colleges and universities often preclude purchase of more expensive laboratory spectroscopic and chromatographic instruments normally found in major universities, their students lack training in operation of these instruments. In this project a prototype spectroscopic laboratory was to be constructed in a step-van type truck which will move from campus to campus for one to two week visits to provide for these students experience in operating these instruments. The costs of upkeep, repair, and replacement are to be shared among the schools which are part of the project. Thus for less than one-fourth the usual cost a school which is part of this cooperative venture should be able to provide their students with hands-on experience with these instruments and upgrade their laboratory experience.

AUDIENCE:

The instruments packaged into this mobil laboratory are designed to enrich the undergraduate chemistry program in the curricula of colleges and universities. The students who take Chemistry in more than three hundred smaller colleges and universities serve as potential users of similar laboratories. In particular this laboratory has circulated among thirteen schools in Arkansas and Kansas to provide instruments for experiments by some 500 undergraduate chemistry students. Because this project seems to be a success other cooperative ventures by other Chemistry Departments are suggested. Other areas of education, such as Physics or Biology, should consider development of similar mobile laboratories.

INNOVATION:

This project has found solutions to four difficult problem areas. First, the laboratory instructors at the cooperating schools must: (a) Incorporate use of the laboratory into the learning process on a sliding time scale since the truck cannot be physically present on but one campus at a time. (b) Alter normal schedules by first prelecturing on the particular spectroscopic techniques and then utilizing the time period when the truck-laboratory is present as efficiently as possible, and (c) Evaluate the overall effectiveness of the project in teaching spectroscopic techniques. Second, in order to operate these instruments, a truck-laboratory has been constructed which can maintain a relatively constant temperature near 74°F. winter and summer. Third, methods have been developed to service instruments that malfunction, and to minimize non-operating time due to repairs. Fourth, a plan is evolving to continue financing the project in the future. (Funds must be found for not only normal service, but replacement of non-repairable instruments as well.) Unless new and unforeseen problems arise these solutions to these problems mean that larger numbers of students can receive better laboratory instruction in Chemistry at less than one-fourth the usual expenditure. At this point in the project these solutions seem to be working effectively.

EVALUATION:

Financial considerations coupled with educational benefits are forming the basis for the success or failure of this project. The thirteen schools which are participants in the project will be asked to begin to pay for the expenses of the laboratory beginning in the fourth year. If the benefits to the students of these schools are high enough and the costs to the schools low enough the mobil laboratory will continue to function. Alternatively if most schools begin to drop out of the project even though they still cannot buy these instruments from their budget funds, then the project will have failed. In order to stimulate needed changes before the fourth year, evaluation conferences are held each year. At these conferences an outside independent panel of three members with wide experience in chemical education is convened to listen to reports given by the cooperating schools and suggest alternative procedures. The results of these evaluations will be widely circulated to Chemistry Departments at the end of the third year of the project. Earlier preliminary reports are available from the project director.

MATERIALS:

At the end of the third year of the project (May, 1978) a booklet which describes the project, the problems and their solutions, and suggestions for other similar cooperative projects will be prepared and mailed to all Chemistry Departments of small colleges and universities in the United States. Others may obtain a copy from the Director. Several summary papers will be submitted for publication to the Journal of Chemical Education.

PROBLEMS:

The most significant aspect of problem solution during the first year involved anticipation of possible problems, and molding preventive measures before the problems occurred. For example, one might imagine that the laboratory would not be big enough to accommodate many students, that the instruments would not operate satisfactorily under the expected wide environmental variations, and that the instruments would be inoperable often due to malfunctions.

To solve the space problem, four of the instruments were mounted in removeable drawers, so that they are removed from the truck and taken to the usual chemistry laboratory of the cooperating school for operation there. Thus, these four instruments can be effectively spaced in the laboratory for efficient student use. The remaining two instruments are permanently mounted in the truck and usually used by one or two students at a time. The space in the truck is adequate.

In order to be sure that changes in the weather would not cause instrument malfunction, a carefully controlled truck environment is essential. To accomplish this, a four inch layer of insulation was built into the reinforced floor, ceiling, and walls. (This careful design and heavy insulation is credited as a major factor in maintaining successful operation of the nuclear magnetic resonance spectrometer.) A thermostat on the air conditioner-heater maintains temperature control. Further, an electrical power generator provides electricity during travel of the truck so that the temperature is kept constant at all times.

Instruments will fail from time to time no matter what is done, and despite built-in ruggedness by the manufacturer. To minimize instrument "down-time" this problem had to be solved. Careful analysis showed that as much as three-fourths of instrument malfunction is a result of trivial problems: a circuit board has jarred loose, the operator does not understand the way in which the instrument functions, the proper button has not been pushed, etc. To alleviate these troubles, a summer workshop was convened to teach personnel at the cooperating schools not only how to operate these particular instruments properly, but how to correct trivial problems, and locate real malfunctions. In this way, most problems can be corrected on the spot by the coordinators of the cooperating schools. Other problems, mostly electronic in nature, are corrected by personnel trained in electronics and manufacturer representatives, when necessary.

The heavy magnet of the nuclear magnetic resonance spectrometer was chained down so that should a traffic accident occur, personnel will not be injured by a heavy flying object.

Frequent failure of the filament on the mass spectrometer forced the director to find a way to provide shop-fashioned replacements at almost negligible cost.

A tow bar was used initially to tow the truck driver's personal car so that transportation for returning home was inexpensive and readily available. This practice was abandoned due to several near serious accidents.

When the truck was first completed a persistent low frequency sine wave was noted in every section of the nuclear magnetic spectrometer, and was traced to a gently rocking motion of the truck on its springs. This was corrected by use of four jack-stands under the floor of the truck.

ADDITIONAL COMMENTS

A full report of the activities of the first year is available from the Director.

February, 1977

Project Number: SED 74-00434 A01 Amount Awarded $34,675

Date Awarded June 1, 1974 Duration 24 Months

Project Title: A STUDY ON COMPUTER IMPACT ON SOCIETY AND COMPUTER LITERACY COURSES AND MATERIALS WITH RECOMMENDATIONS FOR FUTURE DEVELOPMENT FOR THESE COURSES

Project Directors: Richard H. Austing, Gerald L. Engel

Project Address: Association for Computing Machinery,
1133 Avenue of the Americas, New York, New York 10036.
212-265-6300

Purpose: The project had three basic objectives

1) to review and catalog materials related to computer and society courses and programs and to provide methods for dissemination of such information

2) to identify minimum knowledge level requirements for computer literacy

3) to develop behavioral objectives for various types of computer and society courses as well as develop decision mechanisms for materials for such courses

Audience: The project was primarily directed to college instructors desiring information on computers and society and computer impact courses. Secondarily the project developed materials useful to high school teachers, and the public at large, who had an interest in this area of study.

Innovation: The project gathered a committee of experts in computer science and education to both identify the materials appropriate to the study and the course objectives.

Evaluation: Through open meetings, and invited sessions a number of individuals concerned in the area were invited to comment on the project as it developed, and guide the committee as to directions that should be taken. Comments coming from the individuals taking part in this evaluative process were included in the final project report.

Materials: The primary product of the project was an extensive bibliography of materials in the area of computers and society and computer impact. This bibliography is currently available on microfiche from the principal investigators and is being considered as a special publication of the Association for Computing Machinery (ACM). The course descriptions and other materials considered in the project are reported in a paper which is currently available from the principal investigators and has been submitted for publication.

Problems: A significant current difficulty with the computer impact on society course follows from a immaturity of the subject area. A great deal of research and a great deal of conceptual development remain to be done. A generally accepted taxonomy is required before our knowledge can be organized into a useful form. Further, we need much more empirical evidence concerning actural effects of the implementation of computer systems. We need both more refined models which describe and allow the prediction of the impact of computer systems and we need new tools and techniques dealing with the problems of impact. Perhaps most importantly, we need a framework or a mechanism by which the results of the research and development can be applied in a meaningful way to the implementation of computer systems.

Additional Comments: This project was completed, with the final report submitted June 30, 1976.

February 1977

PROJECT NUMBER: SED 72-02682 AMOUNT AWARDED: $7,860,000
DATA AWARDED: January 1972 DURATION: 58 months

DEMONSTRATION OF THE PLATO IV COMPUTER-BASED EDUCATION SYSTEM

Donald L. Bitzer Urbana, Illinois
CERL 61801
University of Illinois 217-333-1138

PURPOSE The main objective of this program was to implement and evaluate the PLATO IV system at the elementary, community college, and university levels. This central objective required the operation of programs in curriculum, system, software, and hardware development; inter- and intra- institutional coordination and liaison; systems operation, including maintenance, author/teacher training and support, and communications; and evaluation.

AUDIENCE The system was developed principally for use in education at all levels from pre-school to post graduate; however, a much broader range of services has evolved (see below). This range of services can, potentially, be of substantial benefit for all individuals and institutions.

INNOVATION The innovations of this program will be summarized according to the categories: system development, hardware development, software development, system implementation, curriculum development, applications research, and media development.

System Development The importance of the system concept, in addressing a problem as complex as CBE, cannot be overemphasized. It is relatively easy to implement hardware, software, curricular materials, or instructional design strategies and fail to make significant progress towards the goal of the program. The entire system problem must be addressed. Particularly, in the case of CBE the entire sequence, from the initial design of the instructional materials, to the translation of this design to code, to the presentation of the materials to students, to the collection of evaluation data concerning this whole sequence must be addressed as a single problem. In addition, overlaying this broad consideration is the problem of evolution. In particular, adequate power and flexibility must be incorporated in order to make modifications and improvements in response to experience gained in the application of the medium. Without this latter feature, a program can quickly run into a dead end, because of the discovery that some preconception is either misleading or totally in error.

Perhaps one of the most important contributions of the PLATO program is in this area of system development. An extremely powerful and flexible medium has been developed which addresses this full spectrum of issues. Lesson materials can be created with relative ease, the system providing powerful capabilities that aid in this process. Thousands of persons, untrained in instructional design or computer technology, have successfully developed instructional materials. The interface with the student has proved to be effective and enthusiastically accepted. The data collection and analysis capabilities are broadly and effectively used. And, finally, a powerful evolutionary capability has been demonstrated. This latter is evidenced through the rapidity of software and hardware development as well as the development of new instructional techniques and new applications which has been and continues to be maintained in the program.

Hardware Development The range of hardware developed prior to and during the operation of the present program is substantial. Most of this development took place outside of the NSF program, however, since this program has been essential to the guidance of this hardware development, it seems appropriate to summarize it here.

The implementation of the PLATO system has required the development of a new and unique display technology, the plasma display panel; a powerful, low-cost graphics display terminal; an interface system to distribute computer output and receive student/author input simultaneously from hundreds of terminals; a communications system to serve terminals locally distributed over either TV of twisted pair linkages and to serve terminals remotely distributed through standard telephone lines, TV, or microwave links; and a series of peripheral devices, including the random-access slide projector, the random-access audio device, the music synthesizer, the touch input system, hard-copy output units, and a variety of specialized instructional and research devices. Present developments include a low-cost replacement for core-based swapping memory, improved communications devices, intelligent termianls, and portable terminals.

Software Development The PLATO operating system and the TUTOR language represent major deviations from the mainstream of software development. Possibly as a result of this, these developments have often been critized and misunderstood by the computer science community. However, during the past one to two years, as the power and effectiveness of the system have been demonstrated, these developments have begun to receive more and more recognition for what we believe them to be--very novel and creative approaches which provide great insight and progress towards addressing the design of software for systems intended for use by the lay (non-computer) population.

System Implementation A major effort under this program has been system implementation. In this regard, a system of over 900 terminals, at more than 140 sites, functioning with a reliability factor of more than 95%, providing more than a million contact hours per year in more than 140 subject areas, and providing a variety of additional services (see below) has been implemented and operates on an around the year around the clock basis.

Curriculum Development The curriculum development programs which have operated during the period of the NSF contract have varied in approach from that of an individual author independently writing lesson materials to that of relatively large curriculum development groups. The output of these programs has been approximately 6000 hours of instructional material in more than 100 subject areas. The types of materials range from simple drill and practice lessons to complex student-controlled simulations. The quality of the materials range from poor to superior, and each of the above types of approach has resulted in materials over this range of quality. Thus, while it is clear that substantial additional work must be done in order to evolve curriculum development procedures to improve effectiveness and efficiency, we have demonstrated the system capability to effectively support a wide variety of development models and instructional designs.

Applications Research Many applications of the system have been explored. These include utilization of terminals in individual classrooms, in learning centers, in offices, in homes, and in "PLATO" classrooms. Many models of use have also been explored, ranging from courses taught essentially totally by PLATO, to partial substitution of PLATO sessions for classroom sessions, to assigned supplemental sessions, to optional use of PLATO in conjunction with normal classroom instruction. Again, varying degrees of success have been observed in each of these cases. The system capabilities support any of the models; however, this area of "applications research" is an area where a great deal of additional work must be done.

Media Development Perhaps one of the most exciting aspects of the present program is one that was not anticipated at the inception of the program. Namely, the roots of a new medium, which is much broader than CAI or CBE, have been established. It is too early to attempt complete characterization of this medium. Perhaps the best that can be done at this time is to describe it as a computer-based information/communications network (CICN). In addition to instruction, the PLATO system provides a broad set of services, including:

1. Electronic mail, including text, graphics, and animation.
2. On-line communications, including text, graphics, and animation.
3. Entertainment, including games, musical presentation, etc.
4. Personal services, including medical, financial, psychological, and education and career planning.
5. Research computation.
6. On-line research.
7. Data processing.
8. Information retrieval and distribution.

In 1976, the PLATO system at the University of Illinois was electronically linked to the Control Data PLATO system at Arden Hills, Minnesota. Through this link, any terminal on one system can operate on the other system, making these services available in a network. For example, electronic mail can be delivered from a terminal (located say in San Diego) connected to the Urbana system to a terminal (located perhaps in Baltimore) connected to the CDC system. In addition, lesson materials, software, and data are transferred from one system to the other through this link.

It thus becomes possible to visualize a national network of PLATO systems providing these and other services to institutions and individuals. The impact of this new medium is difficult to estimate, but the potential for improving communications and access to information is immense. Properly applied, this potential can have profound social and economic benefit to the nation and to the world. This NSF program has brought computer-based education, and more generally computer-based information/communications networks, a large step closer to this vision of the future.

EVALUATION Se "PROBLEMS" below.

MATERIALS A large amount of CBE instructional materials have been developed under this program. Persons interested in receiving listings and descriptions of these materials or in exploring use of them should contact the Project Director at the address indicated above.

PROBLEMS The problems which have been encountered in the program generally resulted from the sheer magnitude of the program itself. Deadlines have been missed because of delays on the part of vendors, failure to make administrative decisions promptly, delays in development of equipment or software, tremendously strained resources, and other problems either within or outside the control of CERL. As a result, some participants have been disappointed or discouraged. On the other hand, when these delays have eventually been corrected acceptance and enthusiasm have been almost universal.

The original cost objective for PLATO service (approximately $1.00 per contact hour in 1976 dollars) has not been met to date; however, substantial progress has been made in this direction (estimates of present costs are in the range of $2 to $4 per contact hour), and all signs indicate that the original objectives are obtainable. Research and development is presently underway in both industry and at the University to reduce costs of terminal equipment, computer equipment, and communications. The results of this development combined with the cost reductions normally accomplished with experience (learning theory) should provide cost characteristics which will allow very broad distribution of the technology during the next decade.

Finally, a comment relative to a continuing problem faced in this program is perhaps warranted. Namely, the problem of evaluation. There is no question as to the importance of monitoring development programs of the present type. This monitoring should be incorporated both to determine the level of success or failure of the program as well as to provide guidance in the evolution of the program itself. The approach adopted by NSF in this program was to contract with an external agency (Educational Testing Service) for an evaluation having a substantial summative component.

This approach has three fundamental difficulties. First, the nature of the PLATO program, during the period of this effort, was highly developmental. This means that great emphasis should be placed on formative, rather than summative, evaluation. The emphasis on summative evaluation continually raises the question as to the appropriateness of proving the program access to evaluation data, for fear that this data might be used to modify the program in an effort to improve performance. It is counterproductive that such a situation should exist during a period when the primary intent is to develop and make an initial demonstration of a system.

Secondly, in the present case, the existence of the external evaluation strongly discouraged efforts to conduct internal evaluation, for fear of imposing too much on students and teachers and for fear of interfering with the external evaluation.

The third difficulty associated with the approach followed by NSF is principally due to the burden placed on the external evaluator. In particular, because of the developmental nature of such a program, it is virtually impossible for an external evaluator to develop an adequate understanding of the program to develop an evaluation design. Even if great effort is expended to develop such an understanding and to prescribe meaningful evaluation objectives and approaches, it is likely that the nature of the program will have changed in the meantime, negating much of the value of the plans made. Only the organization operating the program can have any hope of being able to carry out an evaluation which can keep current with the program evolution. This is an extremely difficult task, even for the operating organization. In addition, the performance of the evaluation by the program itself would provide a greater likelyhood and capability of using evaluation data in the guidance of the program.

If the issue of objectivety is critical, with regard to the operation of such an internal evaluation effort, it would seem that the provision of an external monitor of the evaluation could facilitate such objectivety.

In the present case, we feel that valuable data has been lost, effort has been wasted, and the program has failed to benefit from data which could have been very useful to the program. Because of this experience, we propose that the method of internal evaluation suggested by the above be considered for future programs of this type.

PROJECT NUMBER: SED 72-07365 **AMOUNT AWARDED:** $205,700

DATE AWARDED: July 1, 1972 **DURATION:** 42 months

PROJECT TITLE: COMPUTER ELECTROMECHANICAL TECHNOLOGY

PROJECT DIRECTOR: John Tontsch

PROJECT ADDRESS: Los Angeles Pierce College
6201 Winnetka Avenue
Woodland Hills, CA 91371
(213) 347-0551, x376

PURPOSE:

The purpose was to develop a two-year college level technician program for computer repair. Additionally, it was to establish the mechanism for acquainting potential high school students to consider this area for an occupational career. The intention of the program was to train competent computer personnel to fill a manpower shortage void. Both governmental and industrial studies were predicting that the industry was expanding faster than manpower was being trained to maintain existing and future hardware.

AUDIENCE:

The project was specifically developed for freshman and sophomore college students and for interested eleventh and twelfth grade high school students who attended afternoon classes on the college campus. At any given semester, there were approximately 40 high school students, 50 college freshmen, and 30 college sophomores involved. Other persons to derive benefit from this program were college students pursuing a degree in software and the many industries in this geographic locale which hired the graduates.

INNOVATION:

The unusual aspects dealt with high school students taking college level freshman courses in this occupational study area for college credit. These high school students were able to finish one semester of full-time college work by the time they received their high school diploma.

EVALUATION:

The over-all two-year program is evaluated annually by an advisory board of industry experts and recommendations are incorporated in the program to keep the curriculum abreast of industrial needs. Typically, the advisory board consists of one to three representatives from approximately eight different computer-oriented companies. The students are evaluated in the standard methods by practical and written examinations. The total success for the program is evidenced by the high placement rate of the graduating students.

MATERIALS:

A number of new courses were developed pertaining to computer hardware. In addition, laboratory procedures and even methods of practical laboratory testing were developed to evaluate the student's progress during the program. In the freshman year, textbooks are essentially from publishing companies. In the sophomore year, the textbooks are principally from those vendors whose products are used in the laboratory.

PROBLEMS:

Initially the major problem was that of transporting participating students between the campus and the high school. This problem was resolved by selecting key high schools and moving protable laboratory equipment to that facility. This shifted the burden of transportation to the one instructor rather than to dozens of high school students.

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PROJECT TITLE: PROJECT PROCEED: PROGRAM FOR CONTINUING ENGINEERING EDUCATION

PROJECT DIRECTORS: Lawrence B. Evans
Myron Tribus
Karen C. Cohen

PROJECT ADDRESS: Massachusetts Institute of Technology
Room 66-569
77 Massachusetts Avenue
Cambridge, MA 02139
617/253-6520 or 617/253-4580

PURPOSE:

The goal of Project PROCEED is to develop and test an innovative program of continuing education for scientists and engineers. It is based on the premise that continuing education should help users to develop new skills and understandings related to problems encountered on the job. During its early phase the project invested much effort in design of a new framework and delivery system and in developing prototype materials to evaluate the feasibility, viability, usefulness, and cost of the PROCEED system.

The PROCEED system is to be an "adaptive reference" system, one which contains self-study modules, case studies, and other resources that can be accessed by professionals as needed to solve problems in their work. The first prototype version of the system will cover the field of industrial energy conservation. A national search is underway in which teams of experts throughout the country are interviewing engineers who have recently completed energy conservation projects. The goal of this search is to discover what skills, knowledge, and problem-solving approaches were actually required to solve the variety of problems that arise in practice. The results will form the basis for organizing the first version of the adaptive reference system. A needs assessment is in progress to select a second topic area for development.

Representatives of industry, universities, professional societies, and government are involved in developing the materials and delivery framework. Later in the project a consortium of these constituents is to be formed to manage and operate the PROCEED system once it is completed.

AUDIENCE:

The materials developed by Project PROCEED are intended for graduate engineers and scientists in industry. They may also be appropriate in some instances for use in graduate and undergraduate programs. Although the project will focus initially around chemical engineering, materials are being developed in interdisciplinary application areas with impact on national needs and manpower.

INNOVATION:

The project contains many innovative features:

(1) A problem-centered rather than theory-oriented organization and structure of the system and the materials,

(2) The adaptive reference system, accessible from several levels according to individual user needs,

(3) Self-diagnostics to help users enter and benefit from the system,

(4) Self-assessment exercises at multiple levels throughout the materials to test comprehension and learning, and

(5) Verification of competence leading to possible certification.

EVALUATION:

Evaluation is ongoing at several levels:

(1) Testing each module for clarity, usefulness, and user reactions,

(2) Obtaining user response to use of the system in a variety of real world settings and distribution modes such as print, computer managed instruction, computer assisted instruction, and use alone and with peer groups.

(3) Studying the feasibility of alternate dissemination technologies and their costs, and

(4) Evaluation of the project as a whole by the National Steering Committee.

MATERIALS:

Five experimental print modules dealing with aspects of industrial energy conservation have been developed; they are being revised following field testing and evaluation. The complete module series on industrial energy conservation will contain about 30 modules and is being developed this year. The second prototype program will also contain 30-35 modules. The core of each program in a topic area will involve a set of 30-35 self-study modules (each containing 5-10 units and representing 8-16 hours of study). Other integral components of the system will include abstracts, process solutions, technical solutions, case studies, reference sources, and possibly films and slides. All materials are available from the project office.

PROBLEMS:

The interdisciplinary nature of this project, the innovation of its learning design, and the large number of persons, throughout the country, who are involved, have resulted in a slower start-up phase than originally planned. Most new projects face such problems. The project seems now to be moving on a realistic schedule toward the project goals.

July 1977

PROJECT NUMBER: SED 76-18811 AMOUNT AWARDED: $ 301,900

DATE AWARDED: JUNE, 1976 DURATION: 24 MONTHS

PROJECT TITLE: CONTINUING EDUCATION FOR ELECTRICAL POWER TECHNICIANS AND TECHNOLOGISTS: A MODEL PROGRAM

PROJECT DIRECTOR: DR. PERRY R. MCNEILL

PROJECT ADDRESS: 207 CRUTCHFIELD HALL
SCHOOL OF TECHNOLOGY
OKLAHOMA STATE UNIVERSITY
STILLWATER, OKLAHOMA 74074
(405) 624-5720

PURPOSE:

THE PURPOSE OF THIS PROJECT IS TO MEET THE ELECTRICAL POWER INDUSTRY'S NEED FOR EFFECTIVE CONTINUING EDUCATION OF ITS TECHNICAL EMPLOYEES. EXPANDING TECHNOLOGY IN THE INDUSTRY HAS MADE IT INCREASINGLY DIFFICULT TO PROVIDE THE NECESSARY ON-THE-JOB TRAINING FOR NEW OR INAPPROPRIATELY TRAINED EMPLOYEES. THE PROJECT WILL DEVELOP BOTH FOUNDATIONAL AND "HOW-TO" COURSES IN AN INDUSTRY-WIDE MODEL PROGRAM. THE APPROACH WILL BE TO DEVISE A MODEL FORMAT AND DELIVERY SYSTEM (INCLUDING A MOBILE TEACHING LABORATORY FOR HANDS-ON EXPERIENCE), DEVELOP COMPREHENSIVE COURSE MATERIALS, AND VALIDATE THE PROGRAM THROUGH FIELD TESTING. BESIDES ELECTRICAL POWER, THE RESULTING FORMAT AND DELIVERY SYSTEM SHOULD BE USABLE FOR OTHER SUBJECTS AND BY OTHER INSTITUTIONS.

AUDIENCE:

THE COURSE MATERIALS DEVELOPED UNDER THIS CONTRACT ARE INTENDED FOR CLASSROOM INSTRUCTION OFF-CAMPUS. STUDENTS WILL REPRESENT SEVERAL LEVELS OF TECHNICAL EMPLOYEES IN THE ELECTRICAL POWER INDUSTRY. AT THE PRESENT TIME, IT IS ENVISIONED THAT THE INSTRUCTIONAL MATERIALS WILL BE HIGHLY STRUCTURED TO ALLOW PEER TEACHING.

INNOVATION:

AS VISUALIZED, THE PROGRAM WILL HAVE THE FOLLOWING INNOVATIONS: (1) THE MATERIAL TO BE PRESENTED WILL BE HIGHLY STRUCTURED THROUGH THE EXTENSIVE USE OF AUDIO-VISUAL MATERIALS. (2) THE HIGHLY STRUCTURED PROGRAM WILL ALLOW EFFECTIVE TEACHING TO BE CARRIED ON BY PEER TEACHERS AFTER A BRIEF PERIOD OF TRAINING. (3) HANDS-ON LAB EXPERIENCE WILL BE INTEGRATED INTO THE PROGRAM ON A PLANNED BASIS. THE USE OF A MOBILE TEACHING LABORATORY WILL MAKE THIS POSSIBLE.

EVALUATION:

EVALUATION WILL BE THROUGH FIELD TESTING USING SMALL GROUPS OF STUDENTS ON A FIRST TEST INSTRUCTIONAL UNIT. PRE-TESTING AND POST-TESTING OF STUDENTS WILL BE THE DIAGNOSTICS INSTRUMENTS FOR STUDENT LEARNING OF TECHNICAL MATERIALS. A FOLLOW-UP INTERVIEW WITH STUDENT SUPERVISORS ON-THE-JOB WILL EVALUATE LONGER TERM EFFECTIVENESS. STUDENT QUESTIONNAIRE WILL BE USED AS THE DIAGNOSTIC INSTRUMENT FOR COURSE STRUCTURE AND USE OF VARIOUS INSTRUCTIONAL AIDS.

A SUMMATIVE EVALUATION WILL BE ATTEMPTED BY A REVIEW COMMITTEE MADE UP OF INDUSTRIAL REPRESENTATIVES AND EDUCATORS AFTER SEVERAL DIAGNOSTICS EVALUATIONS HAVE BEEN PERFORMED AND THE PROGRAM FORMAT ADJUSTED.

MATERIALS:

MATERIALS THAT ARE IN DEVELOPMENT INCLUDE UNITS OF INSTRUCTION USING SLIDE-TAPE PRESENTATION, SOUND-ON-SLIDE, TALKING PAGES AND VIDEO CASSETTES. THESE MATERIALS CAN BE MADE AVAILABLE FOR REVIEW AS THEY COME ON LINE.

PROBLEMS:

PRESENT PROBLEMS ARE MINIMAL AND HAVE TO DO WITH DEVELOPING MATERIALS AT THE APPROPRIATE LEVEL OF PRESENTATION. FREQUENT REVEIW SESSIONS ARE BEING USED TO OVERCOME THIS PROBLEM.

PROJECT NUMBER: SED 75-21587A01 AMOUNT AWARDED: $ 67,150

DATE AWARDED: June 26, 1975 DURATION: 24 months

PROJECT TITLE: "THE RETURN ON INVESTMENT IN CONTINUING EDUCATION OF ENGINEERS"

PROJECT DIRECTOR: Albert J. Morris

PROJECT ADDRESS:
Genesys Systems, Inc.
1121 East Meadow Drive
Palo Alto, California 94303
(415) 494-3701

PURPOSE:

The Project is attempting to determine if there exist any relationships between an engineer's participation in continuing education and various measures of job performance and growth in responsibility. Both short-term effects and long-term effects will be explored as a function of the amount and timing of continuing education and a number of other variables such as types of courses, types of teachers, location of courses, credit vs. non-credit, level of employers' financial support and organizational environment.

AUDIENCE:

The results of this Project will be of interest to millions of professionals, including among others engineers, physicians, lawyers, dentists, nurses, teachers and employers of professionals, as well as universities and other purveyors of continuing education programs. All persons who participate in continuing education or who may contemplate it will be interested in whether the time, effort and money they expend brings a meaningful return. Employers may use the results in determining future policy in support of continuing education. Educational organizations may either change what they do and/or what they say about their continuing education programs.

INNOVATION:

A project of this kind is normally and ideally set up as a controlled experiment. One would take a large number of new engineering graduates, separate them into four or five "inherent ability" categories and in each category have some engineers who participated heavily in continuing education and some not at all and some in-between. These groups would then be followed longitudinally over about ten years and then the differences in performance/responsibility would be correlated with continuing education. Such an approach is very expensive and requires funding over a long period of time.

As an alternative, the Project is relying on archival data and the memories of the individual participants. Data should exist in personnel files on salary history and performance reviews. Individual engineers will hopefully be able to reconstruct their participation in continuing education over time. Chief Engineers and supervisors should be able to evaluate engineers who work for them now or who did at one time. If the Project can get enough people to accurately complete the survey forms required, then it might be possible to evaluate the effects of continuing education without the need for a longitudinal study. It is worth attempting to do this because of the relatively low cost and short time scale involved.

EVALUATION:

The Project is looking for a "small signal" (the effects of continuing education) in the presence of a "large amount of noise" (i.e., the effects of initial education and inherent ability). If such a "signal" is detected, then questions of "bias" must be resolved. Biases exist, for example, because the Project is sampling only a few organizations, all of which are located in one geographic area. Also, the participants are all volunteers and this results in a biased sample.

Initial evaluation of methodology is the responsibility of Project consultants and the Steering Committee. They will also be concerned with causal phenomena, evaluating the effects of bias, etc. When they are satisfied, it is assumed that NSF will have its own evaluation group.

Two things are abundantly clear. If the Project obtains positive results, then questions of bias or alternative reasons for these results must be carefully explored because surely the results will be searchingly questioned for validity. If negative results are obtained, there will be serious questions to be answered about the validity of the archival approach. Again, it will be important to determine whether the negative results are real or due to the methodology utilized.

The results will be published in a Final Report to NSF and presumably it will receive reasonable distribution through them. Hopefully, the results will also be published in one or more technical journals and presented at one or more technical meetings.

MATERIALS:

Materials developed include a Study Design, Questionnaires and Instructions for completing the Questionnaires. All are available from the Project Director.

PROBLEMS:

Completing the Questionnaires will be time consuming and involve a lot of work. Information may not be available. Organizations resist the investment in the effort which is costly in people's time. Some organizations do not believe the study is necessary or worthwhile. Others would not believe the results whichever way they come out. Still others just don't care.

Some individuals may not be willing to put in the effort to provide accurate information. Others may volunteer and be less than diligent in completing the Questionnaires. Still others may fake the data to avoid the effort required to give accurate information.

The Project has been successful in getting four major organizations to participate in the Study and to get 25% to 30% of the eligible engineering population to volunteer to participate. Mostly this has been accomplished by perseverance and by finding enlightened top managements who believe in continuing education and who believe it desirable to learn more about its value. As yet, it is not possible to determine the effects of inaccuracy in the data.

PROJECT NUMBER: SED 75-20820 **AMOUNT AWARDED:** $76,620.00

DATE AWARDED: July 1, 1976 **DURATION:** 24 months

PROJECT TITLE: DISSEMINATION OF CONTINUING EDUCATION MATERIALS BY TELEVISION DELIVERY SYSTEMS

PROJECT DIRECTOR: J. Munushian

PROJECT ADDRESS: SSC 510
University of Southern California
Los Angeles, California 90007
(213) 746-7663

PURPOSE:

In 1972, USC's School of Engineering established a 4-channel ITFS Instructional Television System broadcasting courses from the campus to the Los Angeles community. In 1972, also, an NSF grant was received to evaluate this type of educational delivery system, operating in an urban environment, in expanding opportunities for parttime students to pursue degrees in engineering and for older employees to participate in continuing education.

The current phase of this project has the following goals:

1. Large industrial parks, with scores of companies clustered closely together, are becoming increasingly common. Such clusters provide new opportunities for the promotion of continuing education. One promising concept is operation by a university of a continuing education learning center located in the park and conveniently available to employees of all resident companies — both large and small. The learning center would offer courses in a variety of modes, but in this particular project, they are televised from the campus or are available on videotape.

This project is attempting to answer the question: Is such a center useful and feasible? Can it significantly increase the involvement in continuing education of engineers and scientists in the park? Is such a scheme a good model for universities and industrial communities in other parts of the country?

2. Although most large industrial organizations have

training specialists to promote continuing education among employees, small to medium sized companies generally do not. Also, since universities have not specifically attempted to reach employees of these smaller companies, their continuing education needs have largely been neglected. This project is attempting to reach the management and employees of these small companies by direct visitations to educate them about the educational and cost benefits of electronically delivered continuing education — either live or by videotape. The industrial park learning center is a key element in this scheme.

The project is being directed towards answering the question: Can such a direct approach by a university raise the level of participation of these small companies in continuing education opportunities?

3. With the continuing development of electronic recording technology a large library of videotapes suitable for continuing education is accumulating nationwide. However, industry is generally not aware of what is available or its technical and pedagogic quality. This project is attempting to increase this awareness among local companies by enabling them to preview representative tapes obtained from other universities and from industry and professional societies — either by direct electronic transmission or by physical delivery of the tapes.

This project is attempting to answer the following questions. a) Can such a service to industry by a university increase their use of continuing education materials? b) Can assessment of the reactions of local industry employees to these tapes eventually form the basis of a national service that evaluates the quality of tapes for continuing education? c) Can a local service network of this type form the basis for a national continuing education network comprised of interacting university-industry subnetworks around the country?

AUDIENCE:

The program is aimed at engineers, scientists, and technicians working in industry who are in need of continuing education to keep pace with rapidly changing technologies. The program also provides this group with educational opportunities in the areas of management, economic analysis, and personal development. The program takes particular aim at employees of small companies that do not have training staffs.

The Los Angeles area has one of the largest concentrations of engineers and scientists in the world so that the experimental programs being conducted contribute to an understanding of the efficacy and economics of using a live transmission system in serving the education needs of an urban technology working force.

INNOVATION:

Instructional television systems linking schools of engineering with industry are not new but there has been significant growth of such systems in recent years. There are several innovative aspects of the NSF supported program at USC:

1. Normally, television receiving classrooms are established at company facilities. Regional classrooms have been established in leased quarters in large industrial parks so that employees of smaller companies that cannot afford television facilities can gain access to the system. In this mode, employees travel one or two miles to the regional classrooms rather than having to commute tens of miles to the campus. Two such regional facilities have been established and have thus far served employees of more than fifty companies that are not directly tied into the network.
2. The tape preview program, which broadcasts short segments of videotaped courses from other universities and from a variety of other sources, is the first attempt of its kind to publicize continuing education materials to industry.
3. The program also features a liaison person who visits industry, particularly small companies, to familiarize them with the videotape approach to continuing education.

EVALUATION:

The program is being evaluated by various methods. Discussions are held with students taking courses over television to learn their reactions to this mode of instruction. Questionnaires are also sent to industry employees asking them to rate the technical and pedagogical quality of courses broadcast over the system. Ratings developed on the basis of these reactions for courses that are available on videotape are being provided to any potential user organization that requests them.

A Television Advisory Committee comprised of training people from participating companies has been formed and meets periodically with the television program staff to discuss problems and new opportunities.

MATERIALS:

Although development of materials is not part of the grant, some noncredit short courses are being developed and disseminated using the techniques of this program.

PROBLEMS:

At the time of preparation of this report, the present phase of this program is one third completed. As yet, no unanticipated problems have arisen.

ADDITIONAL COMMENTS:

Several other developments related to this grant may be of interest:

1. A new program of live and videotaped minicourses broadcast over the television system during the noon hour is proving to be very popular with industry employees. This program is being offered to industry separately from the principal program that televises regular University courses and at much lower cost. A unique coding system electronically separates the two services.

2. Since this minicourse program uses not only USC courses but videotaped courses from other universities, USC is, in effect, acting as a distributor for other universities in the Los Angeles area. Some of these courses are also directly subleased to companies. A portion of the gross proceeds are returned to the universities providing the tapes.

3. A recent experimental program, in cooperation with a professional society, to present videotaped courses in areas beyond the reach of the live broadcast system has been very successful. The professional society handles all logistics including course advertising and fee collection and receives a share of the proceeds.

February 1977

PROJECT NUMBER: SED 75-19854 AMOUNT AWARDED: $33,120

DATE AWARDED: June 15, 1975 DURATION: 12 months

PROJECT TITLE: STUDIES ON THE USE OF EXTRAMURAL VIDEOPUBLISHED MATERIALS IN CONTINUING EDUCATION

PROJECT DIRECTOR: Douglas Sjogren

PROJECT ADDRESS: Department of Education
Colorado State University
Fort Collins, Colorado 80523
Area Code 303 491-5292

PURPOSE:

The purpose of the project was to evaluate a program at Colorado State University that was designed for continuing education of engineers. The program involved the use of videopublished materials that were available from institutions other than CSU.

AUDIENCE:

The primary audience for the report consists of persons who are considering the use of videotape materials in continuing education as well as other educational settings.

INNOVATION:

The innovations in the program were using extramural videopublished materials, the financing of the program, and the use of the materials for either credit or non-credit classes. The funded project was to evaluate the program and did not introduce any innovations.

EVALUATION:

The evaluation did permit the following conclusions about the program.

1. There is a sizable audience for non-credit type continuing education classes among professional engineers. The program will probably become self-sustaining within a relatively short period of time.
2. The publisher of the tape and course is not a critical issue for the student.
3. Most faculty members are favorable to the use of videotapes as supplementary materials in courses, but there is considerable resistance to the use of complete course packages.

4. The general reaction to the courses in the program was favorable. There was a difference of opinion among participants with respect to the degree of abstraction of the material. Some courses were criticized by some students for being too abstract, but the "practical" courses were also criticized for not developing understanding of general principles.
5. The completion rate of the participants was high. Only a few opted to take the course for credit.

February 1977

PROJECT NUMBER: SED 75 - 21686 AMOUNT AWARDED: $39,974

DATE AWARDED: May 1, 1976 DURATION: 12 months

PROJECT TITLE: INSTRUCTIONAL PROGRAM FOR ADVANCED STUDENTS AND IN-SERVICE PROFESSIONALS: THE USES OF REMOTE SENSING TECHNOLOGY FOR APPLICATION TO ENVIRONMENTAL, LAND USE, AND MINERAL RESOURCES.

PROJECT DIRECTOR: Paul W. Mausel

PROJECT ADDRESS: Indiana State University Remote Sensing Laboratory
Department of Geography and Geology
Indiana State University
Terre Haute, Indiana 47809
812-232-6311

PURPOSE:

The purpose of this project is to develop a three-course program which will provide in-service scientists who have a very limited background in remote sensing with expertise with which they could acquire and interpret remotely sensed data important in their applied earth resources research. The courses are specifically designed to meet the time schedules and professional interests of in-service scientists who are actively employed full-time. Instruction in machine processing of multispectral data and photo interpretation as applied to current data acquisition and research problems is the focus of coursework. This type of program has not been previously available to the designated audience in the form developed in this project.

AUDIENCE:

The courses are intended for students who have a minimum of a B.A. or B.S. degree in any academic discipline and are currently engaged (or intend to be engaged) in one of the following activities: (1) land use planning, (2) mineral resources management, and (3) environmental/ecological analysis. Introductory coursework in physics, computer science and statistics is useful in developing technical expertise in machine processing of multispectral data; however, the applied remote sensing courses developed for the designated audience do not require college level instruction in these subjects.

INNOVATION:

Instructional programs in state-of-the-art multispectral remote sensing are primarily available to full-time students at a few universities. These traditional programs are oriented toward basic research in remote sensing. There are few programs in remote sensing which emphasize applied research in earth resources analysis. The major innovative feature of this project is to provide an instructional program in remote sensing (state-of-the-art machine processing of multispectral data and photo interpretation) for in-service scientists with a minimal background in this subject. The program focuses on the development and interpretation of earth resources data which are vitally needed for application to current environmental, mineral resources, and land use planning issues.

Three courses have been specially designed to meet the needs of the designated audience in order to facilitate participation even while fully employed. All courses focus on meeting the needs of the audience from both an academic and schedule viewpoint. Materials present in the three courses are all oriented toward providing a student with the knowledge to acquire and interpret earth surface information obtained from optical mechanical scanners and cameras carried aboard aircraft and satellite platforms. The three courses of this program are entitled: (1) Principles and Practices of Remote Sensing for Earth Resources Analysts; (2) Applications of Remote Sensing to Land Use, Mineral Resources, and Environment Problems in Non-Metropolitan Areas; and (3) Applications of Remote Sensing to Metropolitan Land Use and Environmental Problems in Metropolitan Areas. All these courses attempt to extract only that information required for the applied research audience to effectively utilize modern remote sensing technology in their work. In-service scientists, with little or no background in remote sensing and without technical expertise which is usually associated with remote sensing analysts, have the opportunity to learn how to effectively utilize selected modern remote sensing techniques in their earth resources related careers.

EVALUATION:

The project is more than half completed (3/77) thus additional evaluation will be conducted before the project is completed. Three student groups have been engaged in coursework developed through the funding of this project.

Two student groups were comprised of in-service urban-regional planners (primarily from Indiana) who are actively employed by the State Planning Services Agency or Council of Governments (multi-county planning groups). One group of 20 students took a full 3 semester hour course in applied remote sensing/non metropolitan land use analysis while a second group of 20 participated in a workshop which presented, in condensed form, materials similar to those which were given during the 3 semester hour course. The workshop participants were regional planners and environmental scientists from Indiana and adjacent states.

A third student group was comprised of Indiana State University graduate students (from California, Wisconsin, Massachusetts, Maine, North Carolina, New York, Indiana, Arizona, Kentucky, Illinois) who are going into land use planning, mineral resources planning, or environmental research following graduation. These students were used to test instructional materials developed for presenting a low cost approach to machine processing analysis of multispectral data. The experience gained in this course using ISU graduate students made it possible to develop a course in hands-on processing of spectral data for the non technically oriented in-service scientist. The course will permit the in-service earth resources scientist to generate his or her own earth surface feature data if desired.

Discussions with class participants and selected supervisors of the various participants have indicated that overall the materials presented fit the background and needs of the students. Valuable suggestions have been made by participants about materials they wish would be added, deleted, or modified. These suggestions are being considered and will be incorporated into the courses where feasible.

Consultations with the technology transfer experts (Drs. Lindenlaub and Morrison) at the Laboratory for Applications of Remote Sensing at Purdue University are being conducted concerning evaluation of the ISU instructional program in low cost machine processing of multispectral data. Evaluation of the applied remote sensing courses have been made by the Center for Urban Regional Studies at Indiana State University in addition to evaluation from class participants and their supervisors. These evaluations indicate the materials developed are meeting the need for which they were intended. Suggestions from all evaluators will be incorporated into future instructional materials.

MATERIALS:

When completed, the project will make available: (1) a manual for "Principles and Processing of Remote Sensing for Earth Resources Analysis" which stresses low cost approaches to machine processing of multispectral data; (2) a manual for "Applications of Remote Sensing to Earth Resources Analysis - (rural)"; (3) a manual for "Applications of Remote Sensing in Urban-Regional Analysis"; and (4) summaries of all manuals for distribution to potential users. The first two of these manuals have been completed. A brochure informing potential coursework participants has been completed and its distribution has begun. Other brochures and announcements are anticipated before completion of the project. These materials will be distributed to universities and agencies which have an interest in developing similar programs or who wish to participate in the established ISU program. Requests for materials (distributed at no cost) should be made to the project director in the Department of Geography and Geology at Indiana State University.

PROBLEMS:

The principal problems associated with the project are those related to (1) obtaining a good geographic distribution of participants and (2) the time framework which was estimated for project completion. The curricula development has been reasonably problem free but it is evident that organization of classes with participants from a variety of earth resources disciplines and geographic areas will take more time than initially anticipated. There has been some difficulty for in-service scientists to schedule the remote sensing coursework even though ISU is very flexible in its offerings schedule. The integration of photo interpretation with machine processing of multispectral data is not as complete as desired because of loss of some project personnel designated as primary photo interpretation consultants. This problem should be rectified in the near future.

ADDITIONAL COMMENTS:

The unfamiliarity of machine processing of multispectral data to the user community has made it difficult to offer courses as soon or with a frequency which is desirable. Good progress has been made in reaching the Indiana land use planners and others interested in earth resources analysis. Within 6-9 months this base of students will be well established. Active coursework training to large numbers of students outside of Indiana-Illinois can be expected within a year.

Because the course development and manuals are well developed it will be possible to distribute coursework materials to potential users both at ISU and at other sites in the United States very soon. It is hoped that distribution of this material in conjunction with manual summaries and other announcements will result in widespread dissemination of the remote sensing program. Realistically an additional 18 months may be needed before the instructional materials developed in this project will reach the total audience for which it was intended; however a large majority of the instructional materials will be completed during 1977.

February 1977

PROJECT NUMBER: SED75-20151 **AMOUNT AWARDED:** $206,200

DATE AWARDED: May 15, 1976 **DURATION:** 14 1/2 months

PROJECT TITLE: THE PREPARATION OF SUPPLEMENTAL INSTRUCTIONAL UNITS BASED ON CURRENT CRUSTAL RESEARCH, FOR USE IN GRADES 8-10

PROJECT DIRECTOR: Edward C. Stoever, Jr.

PROJECT ADDRESS: School of Geology and Geophysics
University of Oklahoma
830 Van Vleet Oval, Rm. 107
Norman, OK 73019
(405) 325-6511

PURPOSE:

The purpose of the project is to develop, as supplements to existing earth science curricula in grades 8-10, a set of 1-3 day instructional units which are based on current scientific research into the composition, history, and processes of the earth's crust and the applications of this knowledge to man's activities. The project is expected to provide one model for shortening the time lag for translation of ongoing research into useful classroom materials.

AUDIENCE:

The instructional activities are intended for junior high school students in earth science courses being taught at grades 8-10. While no current figures are available, the most recent report from the National Center for Educational Statistics indicates that in 1972-73, 558,654 students were enrolled in an earth science course in grades 9-12 (representing 4.2% of that school population), and that a total of 990,184 students were enrolled in this course in grades 7-12, inclusive. The number has been increasing steadily over the past 15 years. In addition, most junior high school age students have an opportunity to take general or physical science courses in which project materials could appropriately be included. Indirectly, it is expected that development of these materials will stimulate development of similar materials at both lower and higher grade levels, including college.

INNOVATION:

Innovative aspects of this project include: (1) the equal participation of junior high school teachers, active research scientists, and science educators in the development of the instructional materials; (2) the "at-home" development work being performed at six development centers throughout the nation; and (3) the involvement of an educational organization, the National Association of Geology Teachers, in an instructional development effort.

The combination of innovative aspects of the project is expected to result in a set of instructional units which will be: (1) concerned with the cutting-edge of research; (2) readily adaptable to existing curricula; (3) low cost, in terms of both development costs and unit costs; and (4) likely to result in continuing development, dissemination, and adoption after the termination of the project t[illegible]gh the continuing activities of the teachers, researchers, a[illegible]GT membership who have participated. Although the project [illegible] only been in operation since August, 1976, the probability o[illegible] success in attaining all of these objectives appears excellent.

EVALUATION:

The developmental operations of the project are continually under review by a 13-person Advisory Board, which includes representation of the populations involved with and/or impacted by the project--parents, teachers, school board members, educational administrators, curriculum specialists, and scientific and educational organizations. The Advisory Board meets twice yearly for a two-day meeting with the Steering Committee, which includes the NAGT Executive Committee, the Development Center Directors, and the Project Director. In addition, project activities are continuously monitored by the Director through site visits, monthly reports, and correspondence, and are shared with the Advisory Board via reports and correspondence.

The development of instructional units itself is organized as a three-stage process, with formative evaluation provisions accompanying each stage. During the initial development of the instructional unit, evaluation is informal, consisting of in-class testing by the teacher involved in the development, and consultation with other teachers and scientists. The second stage of development focuses on the instructional unit itself, and involves collecting data on student characteristics, student behavior, classroom setting, and teacher behavior, and using this information to modify or reject materials developed. The third stage is aimed at contributing information pertinent to the teacher's guide, and involves classroom testing of materials in their intended context in earth science curricula. Each activity will be tested by approximately 150 students in each of the second and third stages. Teachers and schools representative of teacher characteristics, curricula, and student populations, will be selected on a nation-wide basis. While the results of evaluation will be used primarily to improve the instructional units, appropriate syntheses of the results will be published in educational journals.

MATERIALS:

The project is intended to involve two years of developmental effort, followed by a third year of completing second and third stage evaluation testing. At the end of this time, it is expected that separate instructional units on as many as 50 separate topics pertinent to current crustal research, some with variations in style of presentation or conceptual and reading levels, will be available. Current plans are for commercial publication, although arrangements are still pending at this time. In the event that commercial publication does not appear practical, NAGT will undertake to distribute materials through its business office.

PROBLEMS:

The only real problem to date has been the late date (June 17, 1976) of notification of award of the grant. As a result, the directors of the five development centers which could be established in the Fall were unable to arrange for all of the released time which would have been desirable from the Project standpoint. Nevertheless, owing largely to their dedication and self-sacrifice, a great deal was accomplished during the Fall, and with the addition of the sixth center as of January 1, 1977, the Project effort is proceeding quite satisfactorily. As of January 5, 1977, 47 instructional units on some aspect of 45 separate topics related to current crustal research were in some stage of development at the six centers, and at that time it was anticipated that 35 of these units would have completed Stage 2 testing by June, 1977.

ADDITIONAL COMMENTS:

Progress reports on the Project are published regularly in the Journal of Geological Education, the official publication of the National Association of Geology Teachers.

February 1977

PROJECT NUMBER: SED73-10322A01 **AMOUNT AWARDED:** $340,000

DATE AWARDED: November 1, 1972 **DURATION:** 72 months

PROJECT TITLE: AN URBAN EXTENSION: SOME INNOVATIONS

PROJECT DIRECTOR: Dr. Perry Shapiro

PROJECT ADDRESS: University of California, Santa Barbara
Santa Barbara, Ca. 93106
Phone No. (805) 961-2548

PURPOSE:

The urban economics program is designed after the model of agricultural extension. Agricultural extension has played and continues to play an important role in disseminating technological innovations to the agriculture sector. Although considerably different from agricultural extension, the Urban Economics program follows the model of training, research and extension activity within the same program.

The training component of the program is designed to educate public sector decision makers in the scientific techniques of economic and statistical analysis for application to public sector problems. The full program entails over one academic year of traditional class work and a six month internship with various public and private agencies. The students in the program learn the scientific techniques during their formal training and apply them to real world applications during their internship.

The research and extension components are thoroughly integrated in the main program and are part of the student's formal training. Each student, at the end of one academic year of classwork, is sent to one of various public agencies to serve as research interns. Besides participating in the day to day activities of their office (at which time the students learn the political realities of public sector management) students are required to carry out a comprehensive research project, useful to the internship agency with which they work. It is these research projects which introduce the working public sector employee to the possibilities of modern decision science. In this respect, the activity is very much in the spirit of agricultural extension.

AUDIENCE:

The training component is designed for postgraduate master level students who are preparing for employment in the local public sector. In the developmental stages, the program is exclusively for students at the University of California, Santa Barbara. The original plan is to make certain phases of the program (particularly the core courses) available to other institutions. Plans are now being formulated to enlarge the program to include training in planning for underdeveloped countries.

INNOVATION:

Audio tutorial modules of the core analytical materials are currently being prepared off campus at a low cost. The method of preparation is designed to be easily exported.

The course material is being prepared on audio cassettes with printed material to accompany them. The written material is referenced in the audio tapes.

Because of the technical and formal nature of the material covered, the use of audio cassettes with a printed syllabus was found to do as well or better than other modes such as television compatible video tapes. Furthermore, it has the advantage of being relatively inexpensive and thus can be made widely available for users off campus at reasonable cost.

EVALUATION:

The audio tutorial modules are first evaluated for content by leading members of the economics profession. As the materials are developed they are pre-tested on past students and then evaluated in actual classroom use. All evaluation is done with the cooperation of UCSB's Office of Instructional Consultation.

MATERIALS:

In addition to the entire program development and structure, the major materials developed are the audio tutorial modules and the core technical material. It has not been decided how the materials will be distributed. For the period over which they are being prepared, they are available through the Learning Resources Library at UCSB. Some discussion with commercial publishers has taken place, and these have shown interest in the materials.

PROBLEMS:

Our major problem with the entire program has been the supervision of students during their internship training. They quickly identify themselves as employees of the agencies they work for, and find it hard to reserve their student role. In a sense they have two bosses. One is the employer and the second their academic supervisor.

February 1977

Discipline: Pre-College Economic Education

PROJECT NUMBER: SED75-07246 A02 **AMOUNT AWARDED:** $56,600

DATE AWARDED: June 27, 1975 **DURATION:** 18 months

PROJECT TITLE: NATIONAL CONFERENCE ON NEEDED RESEARCH AND DEVELOPMENT IN PRE-COLLEGE ECONOMIC EDUCATION

PROJECT DIRECTOR: Donald R. Wentworth, Pacific Lutheran University
W. Lee Hansen, University of Wisconsin, Madison

PROJECT ADDRESS: Center for Economic Education
Pacific Lutheran University
Tacoma, Washington 98447

PURPOSE:

The purpose of this project was to provide an opportunity for professionals in economics, economic education, and education to assess the state of pre-college economic education, make recommendations for needed research and development, and stimulate educational activities to improve economic understanding among all citizens.

AUDIENCE:

This project was developed for the information of professionals at the national level in the areas of economics, economic education, and education. Forty participants attended the conference, offering a representative sample of their disciplines. The conference was intended to provide a forum by which the participants could assess the status of the economic education field. This will enable them and their colleagues to devise and conduct research projects to correct the problems identified, and to design and implement curriculum materials for use in elementary and secondary schools at the national level. Indirectly, school children throughout the nation will benefit from the education materials developed as a result of the findings of this conference.

INNOVATION:

This project was able to have professionals representing all related areas meet and collectively develop priorities for future pre-college economic education curriculum development. This synthesis of professional judgments will serve as a consensus guide to future curriculum work. The number of professional conflicts and jurisdictional disputes that were an integral part of past curriculum development projects may be reduced by discussion of important issues prior to development activities.

EVALUATION:

This project assessed the existing state of economic education and identified recommendations to improve the level of understanding about economic education and the curriculum materials available to the nation's educators. As such, it has not been evaluated in quantitative terms. However, the content of the conference is being published in a book of proceedings and is available to economists and educators in the United States. The extent to which people use the recommendations for research and curriculum development will determine to what degree the project was successful.

MATERIALS:

Any research results of projects undertaken as a result of the conference's recommendations will likely be available through professional journals as reprints of articles; curriculum projects developed will be available through commercial publishers. No specific projects were begun as part of the conference itself.

PROBLEMS:

The task of publishing the conference proceedings was monumental. The fact that the people involved (director, co-director, editor, paper writers and respondents) were at 15 different locations in the continental United States made communication an extremely difficult process. Another major problems was the length of time required to publish the proceedings. The time and work involved were greatly underestimated by the project directors and compounded by the communication difficulties.

February, 1977

Mathematics and General Science
Discipline(s)

PROJECT NUMBER: SED76-18872 **AMOUNT AWARDED:** $215,800

DATE AWARDED: June 30, 1976 **DURATION:** 36 months

PROJECT TITLE: COMPUTER AND LABORATORY MATHEMATICS

PROJECT DIRECTOR: Robert F. Tinker

PROJECT ADDRESS: 1 Armory Square, Springfield Technical Community College,
Springfield, Massachusetts 01105 Phone: (413) 739-9816

PURPOSE:

The overall goal of this project is to provide access to careers in science and technologies for students with inadequate pre-college academic preparation. The plan is to provide a variety of rich, concrete experiences for students which exploit the intimate connection of mathematics, technology, and scientific ideas. The finished product will be a series of modules designed to cover concepts from mathematics, instrumentation and the conduct of science.

Our hope is that a visually and manipulatively oriented approach to these topics would speed the academic progress of certain students who learn best in these modes. Eventually, we want to test out this hypothesis by generating an instrument that can predict which students will do best with this approach. These ideas can be couched in terms of Cronbach's Aptitude-Treatment interaction paradigm. We plan a formal A-T study in the third year of the project.

AUDIENCE:

Our motivation for this line of investigation stems from the hope that our visually and tactfully rich approach will significantly improve the access to science and technology careers by certain members of groups of individuals who are now largely excluded, in particular women and minorities.

INNOVATION:

The project consists of developing two interrelated courses. The first, the Instumented Laboratory, is a graded series of experiences with the goal of eventually permitting students to undertake a small investigation on their own. The second, Computer and Laboratory Mathematics, covers important pre-calculus mathematical concepts in a laboratory setting making extensive use of a low-cost graphics computer system.

At this early point in the project, a major effort has been in the stabilization of the hardware design. We found it necessary to develop our own material that combined the need for conceptual simplicity, flexibility, interaction, and low cost.

The computer system that we have designed, the Personal Instructional Computer System (PICS) should eventually cost approximately $600. It will be able to execute simple programs loaded from an audio-cassette tape recorder. The most interesting feature of it is a TV interface with a light pen which can draw graphics on the TV and provides a hardware-free means of interacting with the computer. The computer also has a general interface for instrumentation which we call the Real World Interface. This interface is capable of interacting with an HO gauge train, a solar panel, a model house, and the instrumentation system.

The instrumentation system can stand alone and provide a means of measuring the basic physical perameters required in a broad range of experiments--temperature, pressure, force, strain, flow, acceleration, sound, vibration, displacement, light, and specific-ion potentials. Standing alone, these perameters can be read from general purpose analog or digital components or interfaced with a computer, the instrumentation can be used to gather and analyize data.

EVALUATION:

Formative evaluation of the project has begun with volunteer students. The detailed plans for formal evaluation including an AT interaction study are still being made.

MATERIALS:

A number of technical reports will be issued periodically from the project headquarters. The current and planned reports are listed below.

1. "Project Description"--abstracts from the original proposal.

2. "Change in High Education"--a review of the history and strategies for change in education as exemplified by the Commission on College Physics.

3. "The TV Graphics Interface." A technical description.

4. "The Real World Interface." A description of our bus structure and circuits used in the interface.

5. "The Techtronics 31-4010 programs." A listing in descriptions of programs developed.

6. "Progress Report" of the first six months.

7. "Applications of the Personal Computer System."

At the termination of the grant, software and hardware material will be made available through a publisher and manufacturer. Until that time, printed circuit boards for the TV graphics interface are currently being made available at cost and other circuits will be made available as they are developed.

PROBLEMS:

Our most serious difficulty to date has been operating an educational resear and development grant through an institution which is not equiped to handle such grants. This, the UPS strike, and supply difficulty within the electronics industry has considerably slowed our rate of progress and demanded an inordinate amount of bureaucratic work by the project personnel.

March 22, 1977

PROJECT NUMBER: SED75-04822 AMOUNT AWARDED: $140,100

PROJECT TITLE: EDUCATIONAL MODULES DEVELOPMENT FOR THE NUCLEAR FUEL CYCLE

PROJECT DIRECTOR: N. D. Eckhoff

PROJECT ADDRESS: Department of Nuclear Engineering
Ward Hall
Kansas State University
Manhattan, KS 66506
913-532-5624

PURPOSE:

The purpose of this project is to develop a series of educational modules for use in nuclear fuel cycle education. This modules will be designed for use in a traditional classroom setting by lecturers and in a self-paced, personalized system of instruction.

AUDIENCE:

The modules are intended for last year undergraduates, first year graduates, and practicing engineers. A background of basic science, mathematics, engineering science, and introdtory nuclear science is assumed. The modules may be used individually or as part of other courses or programs of study. Also some modules will be able to be used for a public information function.

INNOVATION:

A Nuclear Fuel Cycle Education Committee (NFCEC) composed of university professors active in nuclear fuel cycle education has been formed. Four task Forces were designated for the following major fuel cycle areas: 1. exploration, mining, milling, conversion, enrichment, and fuel forms; 2. fuel assembly design, fuel element fabrication, fuel handling, fuel transport, criticality considerations, and in-core fuel management; 3. fuel reprocessing and waste management; and 4. fuel cycle overview, economics, environmental, safeguards, and net energy models. Other committee members from universities, industry, and government agencies will be added to the NFCEC on a need basis. Also an Advisory Committee of university, industry, and government people has been formed. A liaison group with the Fuel Cycle Division of the American Nuclear Society was appointed by this executive committee. The innovative aspect of these committees is that this is the first time that a nationally-oriented group of university, industry, and government personnel has been formed which enthusiastically supports the development of module preparation for nuclear fuel cycle education. No well-prepared, coherent material now exists, and self-paced instruction methods are, to some extent, novel in nuclear engineering education.

EVALUATION:

All modules are to be prepared in draft form and circulated to the four Task Force (subgroups of the NFCEC) chairmen (Task Force 4 has two co-chairman) as well as the project director for review and removal of egregious errors. These reviewed-modules will then be distributed to all members of the NFCEC as well as Advisory Committee members and associates of the NFCEC and individuals designated as reviewers by the Liaison Group for their review and comments. Each module will be subjected to close scrutiny by students and practicing engineers who are studying or working with the NFCEC, Advisory Committee, NFCEC Associates, or the Liaison Group. All of these comments will be returned to the Task Force chairmen, the module author, and the project director for incorporation into the final module.

MATERIALS:

During the project lifetime and upon completion of the project, the project director will make available, on a cost (non-profit) basis, copies of all materials to whomever expresses an interest. Thus far fifty-one preliminary-draft modules have been prepared; seventeen, sixteen, four, and fourteen from Task Forces 1, 2, 3, and 4, respectively. The subjects include: exploration, mining, milling of uranium and thorium ore; conversion ($U_3O_8 \rightarrow UF_6$), enrichment, conversion ($UF_6 \rightarrow UO_2$), and fuel forms; fuel element design and fabrication; fuel element (new and spent) handling methods; transportation of spent fuel; reprocessing of spent fuel and recycle of uranium and plutonium; fission product waste management; safeguarding the nuclear fuel cycle; economics of the nuclear fuel cycle; in-core fuel management; net energy models of the nuclear fuel cycle; and environmental impact of the nuclear fuel cycle.

The organization of this group is such that use of materials prepared by other groups (where appropriate) is not impeded, rather use is promoted. Materials prepared by similar groups will be used whenever possible.

PROBLEMS:

No serious problems have been encountered. The project has been received enthusiastically by all. Industrial participation presents a slight problem because of work schedules and the proprietary nature of some information needed to complete some modules.

ADDITIONAL COMMENTS:

It is easy to spend too much time in organizing and not allowing enough time for module preparation. This has been overcome by our group because of the enthusiasm of the group and their willingness to accept an organization structure patterned after other groups and one which minimizes administrative time as well as group meetings.

Although nuclear engineering education is not as expansive (people-wise) as other areas, it is very expansive (material-wise). To maintain a reasonable balance with respect to material and people requires careful management. In order to insure that the materials prepared during this project are used as widely as possible everyone who is willing to cooperate and work will be given responsibilities.

PROJECT NUMBER: SED75-03411 AMOUNT AWARDED: $126,775

DATE AWARDED: July, 1975 DURATION: 36 months

PROJECT TITLE: THE DEVELOPMENT OF MODULES FOR THE UNDERGRADUATE CHEMICAL ENGINEERING CURRICULUM AND CONTINUING EDUCATION

PROJECT DIRECTOR: Ernest J. Henley and William A. Heenan

PROJECT ADDRESS: CACHE CORPORATION
Room 12-188
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

PURPOSE:

The purpose of this project is to produce and distribute self-study, single concept, text (print) modules in Chemical Engineering to cover the entire chemical engineering curriculum. From 50 to 100 modules are envisioned in each of seven curriculum areas: control, transport, stagewise processes, design, stoichiometry, kinetics, and thermodynamics. Another purpose, once the modules are written, is to trace prerequisite skills and develop curriculum guides which will be helpful to curriculum planners.

AUDIENCE:

The modules are intended for undergraduates at all undergraduate levels in chemical engineering. They may also be used by chemical engineering graduates who wish to update themselves on more recent methods and developments in the field-continuing education.

INNOVATION:

The field of chemical engineering is almost entirely lacking self-instructional material. The project will involve the entire chemical engineering community in developing this important material. The project also involves using path finding algorithms, once the modules are written, to trace prerequisite skills and develop curriculum guides which will be useful for ordering modules and helping curriculum planners.

EVALUATION:

The entire project is under the guidance and evaluation of a national steering committee. Members of the committee include the country's leading chemical engineers from well known universities. The committee has monitored the project from its conception.

The following evaluation forms have been developed for specific module evaluation: 1) a student questionnaire, 2) a professional acceptance evaluation form aimed at peers, and 3) an editor's guide to determine if the module communicates and accomplishes its objectives.

MATERIALS:

Upon completion, the project will make available 50-100 modules in each of the following areas of chemical engineering: control, transport, stagewise processes, design, stoichiometry, kinetics, and thermodynamics. Each module will be roughly 7 to 15 pages, single-spaced in length.

PROBLEMS:

Enthusiasm for the project has been excellent resulting in good cooperation from all those involved. About 90% of the modules have been commissioned to date. Additional publicity, in preparation, is expected to attract authors for those modules yet uncommissioned.

ADDITIONAL COMMENTS:

The most important step in the use of the modules is an active distribution and marketing strategy. It is planned to have the CACHE Corporation market and distribute the modules through the AIChE (American Institute of Chemical Engineers). One media center will then be providing for adequate distribution and utilization of the modules as well as promoting interests of educational technology in general.

Looking back, it now seems that an additional function could have been added to the project. This would have provided for workshops and conferences to develop the application of the modules to the undergraduate program, that is, to show how the modules are applicable for self-study, student evaluation, and for concept demonstrations in the case of those modules which embody simulation type of computer programs. This still could be achieved by way of a follow-up project.

February 1977

Engineering
Computer Science

PROJECT NUMBER: SED73-06003 A01 **AMOUNT AWARDED:** $102,200

DATE AWARDED: July, 1 , 1974 **DURATION:** 36 months

PROJECT TITLE: DISE--DIGITAL SYSTEMS EDUCATION COMMITTEE

PROJECT DIRECTORS: R. G. Hoelzeman, J. T. Cain, T. W. Sze

PROJECT ADDRESS: Electrical Engineering Department
University of Pittsburgh
Pittsburgh, PA 15261
(412) 624-5396

PURPOSE:

The purpose of the project is to develop or to coordinate the development of state of the art educational materials which can be used by the many schools of the nation involved in the teaching of digital systems to aid in keeping their curriculum abreast of this radically changing technology.

AUDIENCE:

Although some of the material developed is intended for use by faculty in both curriculum development and lecture preparation, the majority of the material generated is intended for undergraduate student use in the general areas of Electrical Engineering, Computer Engineering, and Computer Science. There are over 400 departments of this form in the United States.

INNOVATION:

This project is somewhat unique in that the majority of the developmental and coordination activity is being performed by a large number of well-respected leaders in this educational area on a primarily voluntary basis. Funds from the project are being used mainly for travel, final form preparation, and dissemination aspects of the project. Endorsement for the project has been received from a number of the national professional societies in this academic area.

EVALUATION:

This project is to be evaluated on the quality of the materials developed and disseminated. All materials will be initially reviewed and evaluated by educators and industrial practitioners. In addition many schools will be asked to test the materials with their students and evaluate the success of the materials. The results of this evaluation will be used in improving the quality of the end product.

MATERIALS:

The materials developed by DISE take on many forms including, but not limited to, laboratory manuals, laboratory configurations, individualized instruction packages, software operating systems, case studies, design programs, video tape and film presentations, and several others. Initially these materials will be available primarily from the project directors.

PROBLEMS:

There have been no major problems to date, although there has been some difficulty experienced in maintaining the schedule, primarily because the majority of the DISE effort is on voluntary basis. A reorganization of the committee structure, which should alleviate some of the problems, is presently being considered.

ADDITIONAL COMMENTS:

The specific goals of the project are: to assess Digital Systems Education, both to determine the types of curricula, course contents, lab structures, etc., in present programs and to determine how present programs are meeting the needs of industry and the students; to review existing educational/instructional materials in this area; to develop and/or coordinate the development of new materials; to provide a industry/university forum to foster the exchange of new technology; and to obtain widespread dissemination and use of newly developed or existing materials.

The nucleus of the project is the DISE Advisory Committee, which is an inter-university, inter-industry working group with the specific charter of developing, coordinating the development of, and distributing educational/instructional materials in the digital systems area. The committee consists of 14 members with the academic, industrial, and professional societies sectors represented. The present members of this committee are:

Dr. Wayne Black
Professor Taylor Booth
Professor Thomas Brubaker
Professor James. T. Cain
Professor Yaohan Chu
Professor Ben Coates
Professor R. G. Hoelzeman
Dr. Glen Langdon
Professor Arthur Lo
Mr. Francis Lynch
Professor Larry McNamee
Professor T. W. Sze
Professor H. C. Torng
Professor Raymond Voith

PROJECT NUMBER: SED75-17476 AMOUNT AWARDED: $17,800

DATE AWARDED: June 10, 1975 DURATION: 1 year

PROJECT TITLE: DEVELOPMENT OF AN INTERACTIVE CONVERSATIONAL COMPUTER MODEL FOR LINEAR PROGRAMMING

PROJECT DIRECTOR: Dr. John J. Jarvis

PROJECT ADDRESS: School of Industrial and Systems Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332
(404) 894-2313

PURPOSE:

The project is concerned with the development of a computerized linear programming code which emphasizes flexibility and ease of student interaction. Intended as a pedagogical tool, not a production package, the computer program offers students a wide range of options for solving small (rows times cols $\leq$ 5000) linear programming problems. The system relieves the student from the drudgery of formatting data for computer entry. Instead it permits the student to concentrate on formulating linear programming models and interpreting information available from their solution. The program is called "E-Z-LP."

AUDIENCE:

Linear programming has been a valuable tool for Operations Researchers, Management Scientists and Industrial Engineers since 1947. Recently the technique has spread into Mathematics, Computer Science, Electrical Engineering, Civil Engineering and most of the Engineering disciplines as interest is directed away from finding any feasible alternative and toward finding the most "cost-effective" alternative.

INNOVATION:

The unique feature of this development is an interactive conversational computer model for linear programming which is both user oriented and machine independent. Considerable care is being directed toward substantial user acceptance of the project results. The program includes capability for interacting with the student to create linear programming models during operation, receiving previously prepared models, saving models for future use, handling a variety of constraint types, editing and accomodating alternative objective functions. There is a special "HELP" feature which permits the student to get general or specific information on how to use the program at time of operation.

The student may select a number of algorithm and output options. Algorithm options include the primal and dual simplex methods, either of which may use the upper bounded procedure. A special feature which may be elected is the use of rational arithmetic. In this case the program keeps track of numerators and denominators and utilizes "gcd" arithmetic to reduce all fractions as they are computed.

EVALUATION

An advisory committee of four individuals, representing different institutions in the United States, who are involved in linear programming code development was assembled to guide the development of the computer code. This committee evaluated basic structure developed by the project team and also suggested further inclusions and exclusions to the structure. The results of the evaluation were used to modify the structure from which the current code was developed. The current program has been in operation on Georgia Tech's CDC Cyber 74 since May, 1976, and has undergone several minor refinements. Future effort is planned to expand the evaluation to other institutions and to utilize the results to modify, enhance and improve EZLP.

MATERIALS

EZLP is currently available to any institution for a modest fee for reproduction and mailing. Also available is,a report (100+ pages) which details the design and use of EZLP, including a complete listing of the program. Appendix A of the report is designed to provide an introductory, 3-page handout or a comprehensive, 12-page handout on the use of the program.

PROBLEMS

The main difficulty has been and will continue to be affecting a trade off among (1) flexibility and ease of use, (2) problem size and program capability, and (3) machine independence.

ADDITIONAL COMMENTS

The program is entering a second phase of modification and refinement. The Georgia Tech project team is anxious to receive input from other institutions about EZLP and its use.

February, 1977

PROJECT NUMBER: SED75-18315 **AMOUNT AWARDED:** $50,800

DATE AWARDED: September 1, 1975

PROJECT TITLE: "AN INSTRUCTION AND RESEARCH LABORATORY FOR SYNDETIC DIGITAL-ANALOG COMPUTATION IN SCIENCE AND ENGINEERING EDUCATION"

PROJECT DIRECTOR: A. P. Jensen

PROJECT ADDRESS: School of Information and Computer Science
Georgia Institute of Technology
Atlanta, Georgia 30332

PURPOSE:

The purpose of this project has been to study the feasibility of and the imperatives for a computing laboratory which unifies the concepts of analog and digital computing in information and computer science.

AUDIENCE:

The feasibility study of a Syndetic Computing Laboratory was intended to provide data and results which would permit programs in information and computer science education to determine whether or not an important area of emphasis is being neglected.

INNOVATION:

The School of Information and Computer Science of Georgia Institute of Technology has been supported by the National Science Foundation to investigate the feasibility of establishing an Instruction and Research Laboratory for Syndetic Digital-Analog Computation in Science and Engineering Education.

The impetus for the proposal which led to the funding of this effort came from a recognition within the School that information and computer science education has historically focused sharply on the technology of digital computers. With the explosive emergence of large scale digital computers, higher order language concepts, and the sophisticated integration of hardware and software concepts, information and computer science programs have had their hands full keeping pace with the development of an information technology which has become increasingly committed to digital or discrete data concepts. Educationally, this focus was appropriate and not particularly damaging in the early years of development. Further, the "damage" of effecting a program whose gross product was the illusion of a discrete digital world was ameliorated by the fact that a large percentage of the students seeking education in information and computer science came from a science and engineering background. But now, the picture is different; particularly different in programs of undergraduate education where there is a serious danger of producing a practitioner whose view of the world is a world of discrete and precise data; a practitioner who has not been exposed to notions which contrast accuracy with precision and who has not been exposed to the reactions which take place in continuous systems where data do not exist in a discrete, repeatable form except within the bounds of measurement error. Today's computer science graduate is not prone to question the randomness of a pseudo-random number generator which produces a fixed sequence of "random" numbers for a given "seeding." As repeatable as such a sequence is, it is said to be random enough. In short, today's computer science graduate, undergraduate or Ph.D., is apt to have been ingrained with the notion that bits exist in nature and they are not being taught to question and understand the nature of things which exist in nature as continuous functions. Since this education process ignores a large segment of reality in its focus on the discrete world of digital computers, there has been little need to teach or foster consideration of continuous functions in information and computer science. Such concepts have been left to engineering and the physical sciences where they must be confronted.

As the age-of-computers has emerged the basic concepts of computers have undergone little change. The papers of John Von Neuman are pertinent today. Little new computer technology has been developed since the 1950's. However, that technology has undergone a packaging and economic revolution; vast computer power has been placed in the hands of scientists, engineers, hobbyists, and tinkerers in the form of integrated circuits and things which can be built from them.

In view of this diffusion and dispersal of computer technology into the hands of the willing learners waiting eagerly to complete the cybernetic reality of having their very own expandable, controllable information engines as para-intellectual extensions or reflections of themselves, it seems imperative that Schools of Information and Computer Science must recognize the urgency of the challenge to produce graduates who have a facility not only with digital computers and digital processes but with computers in the perspective of information in its many dimensions and representations. Since information as it exists in real world processes is continuous in nature it is also natural that the newly dispersed technology must be conditioned to deal with it at its points of origin in the form in which it exists. This will require information and computer scientists who are prepared to construct or compose computer-like machines which solve specific problems.

What must these computer composers know? How can they be produced? Given existing programs in information and computer science what changes need to be effected? Must computer composers be engineers? Must everyone become facile in the compositions of computers? Or, is there a new role for the information and computer science major? If so, what must this information and computer science student know?

The innovative issuance of this project is the addressing of these questions via an extensive survey of organizations and individuals and a testing of the hypothesis that there is a new role for information and computer science graduates involving a "binding" of digital and analog processes called Syndetic Digital-Analog Computing.

EVALUATION:

In that this project is a feasibility study not intended to produce an end product other than perhaps a proposal, its ultimate evaluation will be effected through peer review. Thus far, presentations have been limited but favorably received.

MATERIALS:

As this is a feasibility study, only limited facilities have been developed to support testing the central hypothesis. Among these is a small microcomputer system based on a Motorola 6800 processor chip. This system (the NSF-6800) is designed to provide a low cost instructional vehicle which interfaces digital and analog systems and supports laboratory experiments through which students are able to assess the problems and tradeoffs of analog and digital processes. For instance, some laboratory experiments require comparisons of digital integration with analog integrations in which the results of standard digital routines are compared with the results of analog integration using both standard analog integrators and analog integrators built by the students from standard integrated circuits. These comparisons involve standard and arbitrary non-linear functions generated through the facilities of the NSF-6800. A number of such experiments have been developed and are undergoing testing prior to becoming an approved element of the curriculum.

PROBLEMS:

The nature of a feasibility study is that some apriori notions are to be assessed through some prescribed procedures. This study was committed to conducting a survey. The most serious operational problem encountered was the design, distribution and analysis of the survey data.

The most serious conceptual problem has been related to the generation of an objective staff willing to assess the issues and problems of Syndetic Digital-Analog computing without the polarities and predispositions inherent in the devotees of analog and digital systems who have so long sought to eliminate each other.

ADDITIONAL COMMENTS:

A survey of over 5,000 firms, organizations and individuals has been conducted. This survey sought to characterize the computing community (organizations and individuals) and sought reactions to issues of modeling economics, analog-hybrid computing requirements and computer science education. While responses continue to trickle in (with over 500 responses at this time) there appears to be a minuscule recognition of analog computing; there is a strongly felt need for more cost effective modeling; and, a strong implication that most computer science graduates are not being prepared to solve real world problems. Analysis of the survey responses has not been completed at this time.

The hypothesis that there is a role for information and computer science graduates involving a "binding" of digital and analog processes has been tested in an environment which requires the binding of analog and digital processes in the physical construction or composition of computer-like machines which solve very specific problems and which interface the domain of continuous information called the real world.

Information and computer science students from varying backgrounds (Music to Engineering) have been challenged with problems which require a unified application of analog and digital processes. These students have demonstrated that the modular synthesis of functions concept requisite to building higher order hardware functions or systems from lower order functional blocks can be mastered in both digital and analog areas. In fact, it appears that the enterprise of such composition employing standard units with fixed rules of use and application is a very productive way of illustrating the true nature of structured programming as it relates to software production and management. Hence this experience illustrates to ICS students the nature of product engineering and demands an orderly approach to the composition of higher and higher order modules which must be operating correctly before the next stage is initiated. It is somehow almost startling to most students that debugging or troubleshooting must proceed from the "known" rather than the "suspect."

Another observation is that the concept of true and instantaneous parallelism evidenced in analog models is a notion for which traditional information, and computer science students have little intuition. They may be equipped to understand and manage parallel sequential processes and still not comprehend or relate to naturally combinatorial circuits. Thus the true nature and importance of feedback as a dynamic function-production concept is not apparent to them. Through the study of amplifiers applied as summers, and integrators, this notion of feedback can be illustrated, appreciated, and exploited as information relevant phenomena.

It seems both imperative and obvious that people involved in handling information in the framework of the future must know about the tradeoffs and benefits of both analog and digital processes.

PROJECT NUMBER: SED 74-13613 AMOUNT AWARDED: $215,655

DATE AWARDED: September 1972 DURATION 36months

PROJECT TITLE: ENGINEERING TECHNOLOGY

PROJECT DIRECTOR: Allan Juster

PROJECT ADDRESS: Fairleigh Dickinson University
Department of Engineering Technology
Teaneck, New Jersey 07666
201-836-6300, Ext.280

PURPOSE:

The purpose of this project is to improve liaison between the industrial sector and those engaged in programs in college instruction of Engineering Technology. The development plan calls for a work-study program for students, the development of new curricula and laboratories and the evaluation and transfer of life experience into academic credit toward a Bachelor of Science degree.

AUDIENCE:

The program requires the involvement of Engineering Technology students, faculty, college administrators of Engineering Technology and representatives of related industry. Although the primary interest in the past concerned the articulation of two year Engineering Technology programs with the upper two year programs in Mechanical, Electrical and Civil and Construction Technologies respectively, a new four year program with a building construction option has been instituted.

INNOVATION:

Fairleigh Dickinson University is the only private institution in the State of New Jersey offering upper division undergraduate programs in Engineering Technology. In addition students take advantage of work-study programs so that they may gain experience and earn credits and money for tuition.

As a result of our study, the first American Society for Engineering Technology (ASET) has been founded at Fairleigh Dickinson University and has a membership of approximately 200. In addition the Jos. L. Muscarelle Center for Building Construction was completed in 1974 and is devoted to the education of students interested in entering the building construction industry on the middle management level.

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EVALUATION:

The project is constantly being evaluated by the faculty of the Department of Engineering Technology and the Administration of Fairleigh Dickinson University. The best sources for evaluation of the project are the opinions of the students and members of related industry. These inputs provide a constant evaluation of the direction the project is taking. Suggestions from the program manager at NSF have been most helpful in planning or modifying program planning. Another source of evaluation of programs is the Advisory Committee on Technology for the State of New Jersey. The project director sits on this committee and is aware of the latest thinking concerning Engineering Technology.

MATERIALS:

Curricula and course outlines for the following programs have been developed:

Upper Division (Junior-Senior Years)

1. Mechanical Engineering Technology
2. Electrical Engineering Technology
3. Civil and Construction Engineering Technology

Full 4 Year

Building Construction Engineering Technology

These materials along with information concerning the ASET are available either in catalogue form or from the project director. Additional classrooms, offices and laboratories have been provided in the new Jos. L. Muscarelle Center for Building Construction.

PROBLEMS:

The most serious problem arose from the fact that students entering the programs, especially the upper division, had diverse backgrounds and it was difficult to dovetail the Fairleigh Dickinson programs with their previous education. Other problems that were overcome concerned the dialogue with the industrial sector. Because of their busy schedules, it was difficult sometimes to contact interested individuals. These problems were resolved by creating a Council of Industrial Representatives and having evening meetings approximately once a month.

Other problems concerned printing delays, class scheduling, and equipment delivery for which the only solution is to call on one's patience.

ADDITIONAL COMMENTS:

There is no doubt that important additional studies could be added to the project. For an example, it is clear that in general students, teachers, administrators, and industrial employers have different ideas concerning just what is important in Engineering Technology Education. The project would be enhanced by including the development and dissemination of a questionnaire concerning the indicators of quality of college instruction in Engineering Technology. The data contained in the questionnaire could be analyzed with a view toward writing guidelines for the hiring of teachers, curricula planning, and laboratory development.

May 1977

PROJECT NUMBER: SED74-20972 **AMOUNT AWARDED:** $ 70,695

PROJECT TITLE: ENERGY, TECHNOLOGY AND SOCIETY

PROJECT DIRECTOR: Ralph H. Kummler

PROJECT ADDRESS:
Department of Chemical and Metallurgical Engineering
Wayne State University, Detroit, Michigan 48202
(313) 577-3800

PURPOSE:

The purpose of this project is to provide a complete course dealing with energy and its ramifications beyond the scope of that which can normally be offered by any given faculty member. The format to achieve this purpose is a videotaped 55 half-hour module course with self-paced instructional assist. The course is intended to be self-contained and therefore capable of being used without instructor.

AUDIENCE:

The videotapes are intended for undergraduates, primarily those who will not take extensive physical science or engineering. A background of physics and chemistry on the college level should not be needed, as all material has been designed to be equivalent to freshman chemistry and physics courses. The material, however, is of general interest over a much wider range of backgrounds. It is particularly well-suited for a lay audience serious enough to spend 55 half-hours in the pursuit of information about energy.

INNOVATION:

This course has become part of Wayne State University's very extensive TV educational program. It is the only hard science component thus far developed. It involved cooperation between the College of Lifelong Learning, the user of the TV educational program, the College of Engineering, a commercial television network and many of the major universities and colleges in Southeastern Michigan. Thus, specific expertise in virtually every energy area of interest could be and was obtained. The use of the television format provides the opportunity for exciting demonstrations and visuals which cannot be achieved in the ordinary classroom.

EVALUATION:

The TV presentations have been field-tested at WSU by several thousand students. Documentary questionnaires have been completed by a large number of students. The material has been sold to other major universities and feedback from those universities will be requested.

SALES INFORMATION

Lessons: All formats of video tape including videocassette.
Individual lessons and course price available upon request.
Volume order discount from 5 to 20%.

Study guide: Price available upon request.

For Information Contact:
Instructional Services Department
College of Lifelong Learning
Wayne State University
2978 West Grand Boulevard
Detroit, Michigan 48202
Telephone: (313) 577-4592

PROBLEMS:

Success of these TV education programs is highly dependent upon the competence of the director and the TV camera crew. Professional and commercial experience is necessary. But the ultimate control must remain with the academic staff, who must not be permitted to become mere actors in a drama rehearsed by the TV production director. Rather, the faculty must be permitted to develop their own material and to display it in their fashion so that technical expertise can be encouraged and preserved with a minimum time. Otherwise, the project can become a very low technical quality and very high cost endeavor in terms of faculty time.

February 1977

MATERIALS:

PROGRAM NUMBER, TITLE & DESCRIPTION

1 *Energy Problem: Courses and Future Outlook* — Gives overview of the energy problem, what caused it, and what solutions, in general, are available to solve the problem.

2 *Energy in Motion* — Discusses the three forms of energy, potential, kinetic, and internal. Provides information to increase overall understanding of the term "energy."

3 *Chemical Binding Energy* — Discusses the form of energy called Chemical Binding Energy and continues discussion of energy in general.

4 *Electricity I* — Discusses electricity and electrical energy as one of seven forms of energy. As a common source of energy the aspect of high demand and short supply is investigated.

5 *Electricity II* — Continues discussion of electrical energy as related to cost to consumer. Practical applications made to cost for home appliances using electricity.

6 *Energy from Atomic Nuclei* — Explores how energy can be stored and released by nuclei of atoms.

7 *Energy Conversion and the First Law of Thermodynamics* — Demonstrates how to analyze energy flow in typical systems, using the First Law of Thermodynamics and the quantity Enthalpy.

8 *Energy Conversion Efficiency* — Defines the term efficiency, uses examples of home appliances and automobiles to demonstrate concepts of efficiency. Examines efficiency of energy utilization in the United States.

9 *Limits on Energy Conversion Efficiency* — Explains why energy conversion efficiencies often must be less than 100%. Introduces the Second Law of Thermodynamics.

10 *Efficiency of Energy Systems* — Defines the term "system efficiency," and examines the role of efficiency in selecting an energy system.

11 *Developing a Conservation Strategy* — Discusses and demonstrates how to develop an energy conservation strategy for the individual home.

12 *Conserving Natural Gas and Electricity Around the Home* — Discusses appliances for energy consumption and operating costs and how to develop and evaluate strategies for saving natural gas and electricity.

13 *Energy Conservation in the Urban Transportation System* — Identifies the relative energy efficiency of various urban transportation modes and an estimate of the cost of an energy savings program.

14 *Energy Conservation in the Rural Transportation System* — Identifies several factors that must be part of an energy policy determination in intercity transportation.

15 *Energy Conservation Through Alternative Life Styles* — Discusses relationships between our current conservation problems and the life-style patterns of our society. Alternative life-style models and socioeconomic concepts and their effects on energy and resource efficiency are explained.

16 *City Systems I* — Discusses how the world can be divided into four major subsystems including food, resources, nature and cities.

17 *Energy Flows in Nature* — Identifies one of the four major subsystems of the world, "nature", and discusses how it works.

18 *The Food Production System* — Defines the food production system and analyzes its mechanism and efficiency.

19 *The Resource Production System* — Presents an overall picture of energy production and consumption for the years 1952 and 1972 and provides insight into meaning of term "energy shortage."

20 *Mass and Energy Flows in Cities* — Discusses how a city can be considered a physical system and what the inputs and outputs are for the city system.

21 *The Waste System* — Discusses what is in the waste system of the world system and how the system operates.

22 *Feeding the World* — Provides an overview of the problems of feeding the people of the world, the diseases caused by the lack of protein and other nutrients, and identifies possible solutions to the world food problem.

23 *Increasing Food Production* — Gives an overview of current and future ways in which food production could be increased.

24 *Food System Efficiency* — Discusses the efficiency and productivity of our food system and how each can be improved.

25 *Increasing Food System Efficiency* — Discusses how the efficiency of our food system can be increased.

26 *Coal Reserves: Formation and Extraction* — Discusses how coal was formed, the composition of the four types of coal, the United States coal reserves, the various methods of mining coal.

27 *Oil Shale Reserves: Formation and Extraction* — Discusses how oil shale was formed, composition of oil shale, mining and methods of retorting oil shale to produce shale oil, and yields and composition of the products.

28 *Synthetic Fuels* — Provides overview of the U.S. need for synthetic fuels, the basic reactions for gasification and liquefaction of coal, the state of the technology for production of synthetic fuels and some of the problems to bring this large industry into being.

29 *Oil and Gas Reserves: Formation and Extraction* — Provides overview of how oil and gas are obtained, their compositions and how they are processed to yield useful products.

30 *Increasing Oil and Gas Production* — Provides overview of the methods that could be presently used to enhance oil and gas productions from existing wells.

31 *Environmental Effects of Fossil Fuel Production* — Gives an overview of the present environmental effects associated with fossil fuel production.

32 *From Coal to Kilowatts* — Discusses how a fossil fuel power plant works.

33 *Environmental Effects of Burning Fossil Fuels* — Identifies the major problems encountered when fossil fuels, primarily coal, are used to generate electricity.

34 *Nuclear Power Plants* — Discusses how a nuclear power plant (fission) works.

35 *Environmental Effects of Nuclear Power* — Discusses the environmental effects of producing electricity with nuclear energy.

36 *Hydroelectric Power* – Discusses how water and energy flows through the hydrologic cycle, how this energy can be useful to us as hydroelectric power, and the role of hydroelectric power in solving the energy problem.

37 *Geothermal Energy* – Examines the geothermal energy resources of the United States and describes how geothermal energy can be used to generate electricity. Discusses environmental effects of using geothermal energy.

38 *Electric Power Transmission Systems* – Discusses how electricity is transmitted, the advantages of high voltage transmission, and the environmental effects of transmitting electrical energy.

39 *Brownouts and Blackouts* – Discusses how United States electric power system works and what happens when not enough energy is available to meet the demand.

40 *Energy from Solid Wastes* – Discusses how useful energy can be extracted from solid wastes.

41 *Breeder Reactors* – Describes the reasons for developing breeder reactors, the operation of such reactors, and the associated dangers.

42 *Energy from Fusion* – Describes the basic principles involved in releasing energy by fusing atoms.

43 *Principles of Lasers* – Presents and illustrates the operational fundamentals and capabilities of lasers.

44 *Laser Applications to Energy Problems* – Discusses the three major ways that lasers can help ease the energy crisis.

45 *Pros and Cons of Nuclear Power* – Explores the pros and cons of developing nuclear power.

46 *Solar Energy: Energy for the Future* – Provides an overview of status of solar energy technology.

47 *Direct Conversion of Sunlight to Electricity* – Examines how solar energy can be converted to electrical energy.

48 *Solar Heating of Homes* – Examines how solar energy can be used to heat a home and water.

49 *Heat Pumps* – Discusses what a heat pump is and how it works.

50 *Solar Heating with a Heat Pump* – Discusses how a heat pump can be used in conjunction with solar energy to heat a home.

51 *Energy from Winds and Ocean Currents* – Discusses how wind and ocean currents are forms of solar energy and how they can be used to generate electrical energy.

53 *Energy, Economics and Petroleum* – Examines the economic problems associated with petroleum and our policies with the Middle East.

51 *Energy from Winds and Ocean Currents* – Discusses how wind and ocean currents are forms of solar energy and how they can be used to generate electrical energy.

52 *Energy, Economics and Petroleum* – Examines the economic problems associated with petroleum and our policies with the Middle East.

53 *Electrical Utilities and Economics* – Examines the economic problems of utilities, especially as they relate to energy production.

54 *Economics of Energy: Overview and Perspective* – Examines the economics of several energy problem solution policies.

55 *The Energy Problem: Policy and Perspectives* – Contrasts the proposed solutions to the energy problem with the current and projected energy demand for the United States and the world.

PROJECT NUMBER: SED74-18725 AMOUNT AWARDED: $32,185

DATE AWARDED: May 15, 1974 DURATION: 27 1/2 months

PROJECT TITLE: FACTORS INVOLVED IN ATTRACTING AND RETAINING BLACK AMERICANS IN ENGINEERING

PROJECT DIRECTOR AND CO-DIRECTOR: William K. LeBold and Arthur J. Bond

PROJECT ADDRESS: Purdue University
West Lafayette, Indiana 47907
317-749-2594

PURPOSE:

This report was prepared in conjunction with a comprehensive series of investigative studies and experimental projects conducted under grants from the National Science Foundation. The investigative studies were directed at identifying the various factors associated with the relatively low proportion of minorities who have pursued careers in science. The experimental projects were directed at assessing effectiveness of various experimental projects directed at increasing the number and proportion of minorities in science. The number and proportion of Black Americans who are attracted to and retained in engineering programs in the United States have been traditionally very low.

Purdue University's Schools of Engineering have been actively studying its black engineering students and graduates during the past ten years. Recent efforts have concentrated on assessing the needs of black engineers and providing viable programs to increase not only the number that complete four year B.S. engineering programs, but also to increase the number that complete alternative four year college programs. This study focuses on the evaluation of those programs as well as an indepth study of the problems associated with attracting and retaining black students in engineering.

The objectives of this investigation were as follows:

1) To analyze the factors associated with the selection of engineering as a career by black students who have entered Purdue during recent years.

2) To analyze the factors associated with the retention and graduation of black engineering students.

3) To examine in detail the impact of special programs on the selection of the engineering and retention of engineering by black students at Purdue and to identify new programs that may be needed.

4) To examine the post-college careers of Purdue Black American engineering graduates.

5) To recommend policies, practices and programs that can be used by engineering institutions in general to attract and retain black students in engineering.

AUDIENCE:

This project is directed at providing engineering education and the engineering profession with information regarding the recruitment and retention of Black Americans in engineering. Other groups who may be interested in the results would be those concerned with minorities especially Black Americans and their participation in higher education and non-traditional fields.

EVALUATION:

This report consists of four monographs prepared to examine within a single institution (Purdue University) the factors associated with attracting and retaining Black Americans in engineering. The focus of the first monograph is on trends and statistical analyses conducted to establish an objective data base for examining the factors associated with recruiting and retaining Black Americans in engineering at Purdue University. The second monograph focuses on the expectations of incoming Purdue engineering freshmen, including black and non-black students with regard to college, Purdue and engineering. The third monograph focuses on the factors associated with retention of Black Americans in engineering at Purdue. The fourth and final monograph focuses on the post-baccalaureate careers of Black Americans who graduated in engineering from Purdue University.

MATERIALS:

The primary results of the study are the comprehensive sets of objective and survey data on the factors related to the recruitment and retention of Black Americans in engineering. The four monographs summarize the results of the study and are expected to be available in April 1977 from the Department of Freshman Engineering, Purdue University, West Lafayette, Indiana 47907. The results of the study are summarized in the final report, "Recruitment and Retention of Black Americans in Engineering at Purdue". It includes the following monographs:

1) Trends and Statistical Analysis
2) Freshman Expectations of College, Purdue and Engineering
3) Engineering Students: Persisters, Withdrawals, Transfers
4) A Follow-Up Study of Black Engineering Graduates

A summary of the results will be distributed to U.S. engineering colleges and the major engineering societies.

February 1977

PROJECT NUMBER: SED71-04421 **AMOUNT AWARDED:** $118,925

DATE AWARDED: January 12, 1972 **DURATION:** 36 months

PROJECT TITLE: DEVELOPMENT OF A SOCIO-ENGINEERING PROGRAM

PROJECT DIRECTOR: George C. Lee

PROJECT ADDRESS: State University of New York at Buffalo
Buffalo, New York 14214
(716) 831-5325

PURPOSE:

The purpose of the socio-engineering program is to provide the student with a skill-oriented problem-solving education that teaches understanding of social and environmental problems and provides for the application of existing technologies towards implementation of solutions to those problems. This is to be accomplished by making quantative skills learned through civil engineering approaches to problem solving coupled with multi-disciplinary study (sociology, economics, etc.) of the problems themselves. The program is aimed at undergraduate students and uses traditional coursework, special problems, and seminars to accomplish its goals.

AUDIENCE:

The program is addressed to undergraduate students at all levels of the university. However, the course work developed is concentrated in the junior and senior years. The primary audience is, because of the interests of the project leadership group, students initially attracted to engineering. However, students in other disciplines are encouraged to take part in the program. The program has attracted students with diverse backgrounds including environmental design, management science,geography and political science. The students are expected to have a basic course in differential and integral calculus. Because the courses developed are independent of each other, it is possible and desirable that students not enrolled in the comprehensive program take specific courses of their own interest. These courses are primarily in technology impact and assessment and mathematical modeling of social phenomena.

INNOVATION:

Through the techniques of courses, independent study on special problems and special seminars, students are exposed to a variety of issues and people that help them understand more clearly complex social problems and possible methods of solution of these problems.

Brief examples of some regular courses are listed below:

Planning Civil Engineering Systems
Transportation Modeling: Methodologies
Impact of Technology Upon Physical and Social Environment
Transportation Modeling: Applications
Urban Systems Modeling and Analysis
Patterns of Problem Solving
Methods of Analysis
Large-Scale System Analysis and Optimization
Urban Systems Models
Systems Modeling in Environmental, Energy, and Related Areas

Special Topics - For advanced students to attack problems in health-care delivery, housing choice and transportation impacts.

Seminar Series and Specialty Conference - These activities are planned to integrate classwork with real world problems. The seminar series was arranged so that members of the S-E advisory board could interact with the students for a day discussing particular problems of interest to the members. The specialty conference was developed because work revolving around the curriculum and associated faculty interest indicated that there needed to be a cohesion of thought in what we have termed here human factors. Not the traditional industrial engineering definition, human factors here refers to the assessment of physical, physiological and psychological aspects of people that must be considered in planning and design. As socio-engineering has been concerned with people-oriented problems, the methods must deal with measurements from these people. Aggregate engineering planning and design methods are often becoming absolute.

EVALUATION:

There are three basic methods of evaluation of the program. The first is through periodic visits and program study by an outside panel of eminent socio-engineers. Their duties include visits with the associated faculty to discuss course work and informal discussions and meetings with the students. They also submit periodic formal reviews of the program. The second methods involves inter-faculty review. The faculty constantly meet to discuss program, and program content and student response. Courses are dynamic in that there is always an updating of curriculum. The third is review by the students. This takes the form of course review and analysis of seminars. The results of all three processes lead to a yearly review of the course offerings and instructors and a reevaluation of course content before the course is reoffered.

MATERIALS:

Notes from two courses are now being rewritten and edited. The course on modeling will result in a text on application of current modeling techniques to social problems. In addition to traditional statistical models, psychological, behavioral and economic models will be included. The book will incorporate a guide to associated computer use for model development. The course on impact will be used to develop a monograph on qualitative and quantative aspects of technological planning and assessment. A companion volume of readings will be developed to give the student a broad background in state of the art thinking of the role of technology.

A monograph is being developed from the seminar on human factors. The monograph will incorporate an overview, state-of-the-art look at the current field, together with sections on the definition of psychological, behavioral and physiological factors and theories of developing design criteria based on these factors. This will be a milestone volume in an attempt to incorporate human needs in the design process. In addition, monographs from student projects are being developed in conjunction with the different courses.

PROBLEMS:

The program was initially conceived during the tumultuous design of student unrest. The central goals of the program were more broadly based - where does technological planning fall in all of our problems. As the student needs changed, especially to a more disciplined professionalism, it was necessary to focus on more concrete issues - housing, delivery of health care, transportation. Thus the program has become perhaps a little more focused than desire, because of student wishes.

Another unforeseen problem has been the ability of others in other departments to cooperate in extending the discipline of the program. Tight budgets have made it necessary to intensify individual work in each department (i.e., sociology, etc.), giving faculty members less time for interaction. This problem has been alleviated somewhat the forming of a joint committee with the School of Architecture and Environmental Design. This will permit, not only development of courses with more broadly based input, but will extend the offerings to a wider, but still responsive audience.

A difficulty in evolving a program that is attempting to show how values are used to aid in understanding, hence, defining problems, is that values change. Thus, a program, initially conceived of to be a totally integrative program, will become more restricted as individual (faculty and student) define their interests more clearly. This is, in the long run, beneficial. The broad base of quantative assessment techniques has been kept, but the applications become more problem specific.

May, 1977

PROJECT NUMBER: SED 74-22657 AMOUNT AWARDED: $ 199,000

DATE AWARDED: JUNE, 1974 DURATION: 30 MONTHS

PROJECT TITLE: DEVELOPMENT OF AN UPPER-DIVISION ELECTRICAL POWER B. S. ENGINEERING TECHNOLOGY CURRICULUM

PROJECT DIRECTOR: DR. PERRY R. MCNEILL

PROJECT ADDRESS:
207 CRUTCHFIELD HALL
SCHOOL OF TECHNOLOGY
OKLAHOMA STATE UNIVERSITY
STILLWATER, OKLAHOMA 74074
(405) 624-5720

PURPOSE:

THE PURPOSE OF THIS PROJECT WAS TO DEVELOP A MODEL, UPPER-DIVISION ONLY, CURRICULUM IN ELECTRICAL POWER ENGINEERING TECHNOLOGY. THE CURRICULUM WAS IMPLEMENTED AT OKLAHOMA STATE UNIVERSITY IN THE SCHOOL OF TECHNOLOGY. STUDENTS WITH TWO-YEARS OF TECHNICAL TRAINING WERE ADMITTED IN THE FALL OF 1975. THESE STUDENTS COMPLETE THE REQUIREMENTS FOR THE B. S. ENGINEERING TECHNOLOGY DEGREE IN MAY, 1977.

AUDIENCE:

THE MATERIALS DEVELOPED UNDER THIS PROJECT ARE INTENDED FOR ADMINISTRATORS AND TEACHERS OF TWO AND FOUR YEAR COLLEGES OR UNIVERSITIES. OF SPECIAL INTEREST IS THE PROJECT FINAL REPORT THAT CAREFULLY OUTLINES THE DEVELOPMENT OF THE PROJECT, INCLUDES SAMPLES OF MATERIALS USED TO HELP THE PROGRAM ACHIEVE SUCCESS. THIS REPORT ALSO INCLUDES AN ORDER BLANK FOR INSTRUCTIONAL COURSE SYLLABUSES DEVELOPED FOR EACH SPECIALTY COURSE.

THE FINAL REPORT SHOULD ALSO HOLD STRONG APPEAL FOR STATE EDUCATIONAL PLANNING GROUPS CONSIDERING NEW TECHNOLOGY CURRICULA AND FOR COMPANIES IN THE ELECTRICAL POWER INDUSTRY THAT ARE EVALUATING MANPOWER NEEDS. THE FINAL REPORT INCLUDES AN EXTENSIVE EQUIPMENT LIST AND A RECOMMENDED FACILITY FOR INSTRUCTION.

INNOVATION:

THE CURRICULUM IS INNOVATIVE IN THAT ALLOWS ENTRY OF STUDENTS WITH DIFFERENT TECHNICAL BACKGROUNDS FROM A VARIETY OF INSTITUTIONS. THIS INNOVATION ALLOWS THE TECHNICAL STUDENT TO ADJUST HIS EDUCATION GOALS MID-WAY THROUGH A BACCALAUREATE PROGRAM WITHOUT LOSS OF CREDIT

AND HAVE AN EXTREMELY VERSATILE TECHNICAL BACKGROUND UPON GRADUATION.

IT IS FELT THAT THE TWO-YEAR DELAY IN OFFERING ELECTRICAL POWER AS AN OPTION IS A POSITIVE FEATURE OF THE PROGRAM. THIS DELAY ALLOWS STUDENTS TO MATURE AND MAKE BETTER JUDGMENTS AS TO CAREER OPPORTUNITIES AND THE NEEDS OF INDUSTRY. THE LOW-PROFILE ELECTRICAL POWER INDUSTRY STILL SEEMS TO LACK APPEAL FOR FRESHMAN STUDENTS. THIS LACK OF APPEAL IS LARGELY DUE TO A LACK OF KNOWLEDGE ON THE STUDENT'S PART AS TO WHAT ELECTRICAL POWER CONSTITUTES AND HOW BROAD OF A FIELD IT ACTUALLY IS.

A GREAT DEAL OF INNOVATION HAS BEEN USED IN TRANSFORMING STANDARD INDUSTRIAL EQUIPMENT INTO VIABLE INSTRUCTIONAL EQUIPMENT. THIS TRANSLATION OF EQUIPMENT FROM ONE PURPOSE TO ANOTHER HAS BEEN TIME CONSUMING, BUT REWARDING IN THAT STUDENTS BECOME INVOLVED AND DEVELOP A PROBLEM-SOLVING RESOURCEFULNESS NOT ORIGINALLY ENVISIONED IN THE PROGRAM.

EVALUATION:

THE MODEL CURRICULUM WAS DEVELOPED THROUGH THE EFFORTS OF THE PROJECT STAFF, A GROUP OF ELECTRICAL POWER INDUSTRIALISTS, AND A GROUP OF TECHNOLOGY AND ENGINEERING EDUCATORS. TWO SEPARATE CONFERENCES WERE HELD AT THE INITIATION OF THE PROJECT. THE FIRST CONFERENCE WAS WITH REPRESENTATIVES OF THE ELECTRICAL POWER INDUSTRY TO RECEIVE INPUT AS TO WHAT SHOULD BE INCLUDED IN THE CURRICULUM. THE SECOND CONFERENCE WAS WITH NOTED TECHNICAL EDUCATORS TO DETERMINE BEST STRATEGIES FOR ORGANIZING THE TECHNICAL MATERIAL FROM A LEARNING-TEACHING POINT OF VIEW. MEMBERS OF BOTH CONFERENCES WORKED WITH THE PROJECT STAFF ON A CONTINUING BASIS TO INSURE AN OPTIMUM PROGRAM.

THE PROJECT GRANT TERMINATED PRIOR TO THE GRADUATION OF THE FIRST CLASS. HOWEVER, A CONTINUATION PROPOSAL IS NOW BEFORE N. S. F. TO INSURE AN EVALUATION OF THE PROGRAM AND TO DETERMINE IF THE DEVELOPED CURRICULUM IS A NATIONAL MODEL. THIS PROPOSED EVALUATION INCLUDES A DIAGNOSTIC EVALUATION BY GRADUATES AFTER BEING ON THE JOB A SHORT TIME, AND AN EVALUATION OF GRADUATE PERFORMANCE BY THEIR SUPERVISORS. A SUMMATIVE EVALUATION IS ALSO PROPOSED THAT WOULD CONSIST OF A REVIEW OF THE DIAGNOSTIC EVALUATIONS BY A PANEL OF EDUCATORS TO BE NATIONALLY SELECTIVE. THIS GROUP WILL DETERMINE IF THE MODEL DEVELOPED IS A TRULY NATIONAL MODEL THAT COULD BE ADOPTED BY A VARIETY OF INSTITUTIONS.

MATERIALS:

THE PROJECT STAFF HAVE DEVELOPED A COURSE SYLLABUS FOR EACH SPECIALTY COURSE IN THE MODEL CURRICULUM. EACH SYLLABUS HAS BEEN REVIEWED BY THE PROJECT ADVISORY COUNCIL MADE UP OF REPRESENTATIVES OF INDUSTRIES AND EDUCATORS. THESE SYLLABUSES CONTAIN COURSE OUTLINES, DAILY LESSON PLANS, SUGGESTED LABORATORY EXPERIENCES AND SELECTED BIBLIOGRAPHY.

IN ADDITION, THE PROJECT FINAL REPORT CONTAINS AN EVALUATION OF RESOURCE MATERIALS, EQUIPMENT NEEDS AND FACILITY LAYOUT. THESE MATERIALS ARE AVAILABLE AT COST THROUGH THE PROJECT DIRECTOR.

PROBLEMS:

WHILE THERE HAVE NOT BEEN ANY UNSURMOUNTABLE DIFFICULTIES THERE HAVE BEEN SOME MINOR PROBLEMS DURING THE FIRST YEAR OF THE PROJECT. THE ORIGINAL PROPOSAL ANTICIPATED THAT APPROXIMATELY 50% OF THE STUDENTS IN THE FIRST CLASS WOULD HAVE A MECHANICAL BACKGROUND. THE FIRST CLASS ADMITTED IN THE FALL OF 1975 ONLY HAD 25% MECHANICAL STUDENTS.

ANOTHER PROBLEM HAS BEEN THE RELATIVELY LOW NUMBER OF STUDENTS WHO WERE AVAILABLE FROM OTHER STATE INSTITUTIONS TO TRANSFER INTO THE PROGRAM. INSTEAD OF THE ANTICIPATED 50 STUDENTS ONLY 22 ARE ACTUALLY ENROLLED IN THE PROGRAM.

A PROBLEM THAT WILL NOT BE UNIQUE TO OKLAHOMA STATE UNIVERSITY IS ADOPTING THE MODEL CURRICULUM TO THE UNIVERSITY STANDARD. IT SIMPLY BECOMES A TRADE OFF OF WHAT IS REQUIRED BY THE UNIVERSITY AND WHAT THE ADVISORY GROUPS RECOMMEND FOR THE MODEL CURRICULUM.

CONSIDERABLE TIME HAS BEEN SPENT AND MORE WILL BE REQUIRED TO CONVERT THE EQUIPMENT DONATED BY INDUSTRY INTO AN EDUCATIONAL PACKAGE. IT WILL, HOWEVER, BE TIME WELL SPENT.

FEBRUARY, 1977

PROJECT NUMBER: SED 75-20464 AMOUNT AWARDED: $ 135,970

DATE AWARDED: September 1, 1975 DURATION: 24 months

PROJECT TITLE: A PROGRAM FOR THE DEVELOPMENT AND DISTRIBUTION OF MODULARIZED EDUCATIONAL MATERIALS FOR MANUFACTURING PRODUCTIVITY EDUCATION

PROJECT DIRECTOR: Colin L. Moodie

PROJECT ADDRESS: Purdue University
School of Industrial Engineering
West Lafayette, Indiana 47907
Phone: (317) 493-3116

PURPOSE:

The purpose of this project is to set up an on-going national committee of prominent academicians and some industrialists who are concerned with manufacturing or production engineering education. This committee has been established and encourages and facilitates the development of educational materials (print modules, for example).

AUDIENCE:

The educational materials which are being developed are intended for educators (and hence their students) who teach courses which are in part or wholly concerned with modern aspects of manufacturing or production engineering education. This will primarily include departments of industrial and mechanical engineering, and possibly some industrial operations departments in business schools and some advanced technology school curricula. The materials will also be of value for continuing education and in-house industry training programs.

INNOVATION:

The material being developed is concerned with the more modern, often computer controlled, aspects of manufacturing/production engineering. In many instances this material has not found its way into textbooks because of the long lead time associated with textbook preparation and publication. The print modules being developed will lend themselves to individualized instruction or use as lecture supplements.

Some of the material would not otherwise find its way into printed educational materials because of its specialized nature. The national committee of educators and industrialists and the four task forces bring extensive experience and expertise to the selection and development of this material.

EVALUATION:

The national committee, known as MAPEC, and the project directors, have established quality standards for all learning packages to be developed. The entire MAPEC group is associated with four task forces, each of which is concerned with a specific aspect of manufacturing productivity education. These task forces initiate the development of the learning modules and review the completed materials. The specific task forces also monitor a field test program for the materials and direct any material revision which results from the field tests. A strong emphasis for developing high quality relevant materials is maintained.

MATERIALS:

The expected output from the first two years of this project is the following: 1. A report on the availability and adequacy of educational materials for computer assisted manufacturing processes, manufacturing process science, software systems for production control, and laboratory instruction in these areas. 2. A survey of the teaching methods used for university education in these areas. 3. Six learning units (modules) and two laboratory experiments to be prepared and distributed to educational institutions for testing.

PROBLEMS:

After approximately eighteen months of project operation the one major problem experienced by the project directors is control of the writers' progress. Since the writers are not under any direct administrative authority from the project directors, and often they are writing for little or no honorarium, they may give module writing a low priority relative to other tasks they must perform for their home organization. This situation often makes scheduling for project productivity difficult.

ADDITIONAL COMMENTS:

Despite the writer procrastination problem described above, the project is experiencing above average productivity. At least fifteen print modules are in various degrees of completion and it is expected that at least ten of them will be printed in module format in sufficient quantity for student field test by August, 1977.

February 1977

Civil Engineering
Traffic Engineering

PROJECT NUMBER: SED 72-07685 AMOUNT AWARDED: $48,800

DATE AWARDED: May 15, 1975 DURATION : 17½ mos.

PROJECT TITLE: TRAINING AIDS IN TRAFFIC-SIGNAL ENGINEERING

PROJECT DIRECTOR: Peter S. Parsonson

PROJECT ADDRESS: Georgia Institute of Technology
School of Civil Engineering
Atlanta, Georgia 30332
Phone No. (404) 894-2244 or 2204

PURPOSE:

Project SED 72-07685 was a follow-on to project GZ-2561, of the same title. The purpose of these projects was to provide a series of four 16-mm instructional films, totaling approximately 85 minutes in length, on the timing of vehicle-actuated traffic signals at local (isolated) intersections. Each film is a blend of scenes of Atlanta intersections, graphical animation, and demonstrations in the Georgia Tech Traffic Signal Laboratory. The films are needed because the pressures of urban traffic congestion have forced increased emphasis on traffic engineering techniques to obtain the maximum utility from our existing city streets. There is currently an urgent need for traffic engineers who understand the latest technology and are able to apply it in practical situations. Eight sets of the films are in constant circulation throughout North America and Europe.

AUDIENCE:

The projects were developed primarily for Masters degree students of traffic engineering, which is a branch of civil engineering. This audience comprises approximately 500 viewers annually. Part I of the films has proven to be appropriate also for undergraduate civil engineering courses in basic highway engineering, and has even been shown to high school seniors as an orientation to engineering. In addition, the films are used for graduate-level short courses offered by universities, governmental agencies and consulting firms. The total audience is currently at a level of approximately 2000 per year. The availability of the films is publicized without charge by the Institute of Transportation Engineers and the Federal Highway Administration.

INNOVATION:

Only motion pictures of laboratory demonstrations, accompanied by graphical animation, appear to be suitable for the teaching of the dynamic interactions of traffic-actuated signal control.

It is an innovative solution to an instructional problem in that it never had been done before and it was not known for sure that such instruction would be accepted by instructors and students. This solution results in an enormous advantage over the traditional chalkboard technique. The evaluations show that the films are successful in that they enable the viewers to time their traffic signals for maximum efficiency and safety.

EVALUATION:

Until mid-1976 each borrower received an evaluation form and a multiple-choice quiz with answer key for his possible use in determining the effectiveness of each film. The filled-out evaluation forms were returned with the films and are tabulated by the Project Director. The tabulation through December, 1974, was used to aid in evaluating the proposal for the fourth film.

MATERIALS:

The following films have been developed and are available on free loan from the Audio-Visual Department of the Georgia Tech Library:

Part I, Basic Actuated Controllers	24 minutes
Part II, Advanced Actuated Controllers	16 minutes
Part III, Multiphase Actuated Controllers	13 minutes
Part IV, Loop-Occupancy Control	30 minutes

PROBLEMS:

The films were produced with the philosophy that students, especially graduate students, must take a more active role in their education. Therefore, the Project Director expects that a serious graduate student will be willing to show each film to himself several times before he is satisfied that he can take the quiz successfully. Parts II and III, especially, incorporate so much technical material that it is virtually mandatory to see these films a second and third time. There has been no problem with Georgia Tech graduate students in this regard; but there is evidence that many instructors simply are not oriented to multiple viewings, despite the fact that the Notice of Film Mailing sent by the Project Director specifically recommends this. Preliminary indications are that many instructors show the films only once and do not administer the quizzes.

ADDITIONAL COMMENTS:

Parts I, II and IV are supplemented by papers published in Traffic Engineering. Therefore the film viewer has some hard-copy material available that is quite similar to the film content. The Ohio Department of Transportation went a step beyond this by requesting a copy of the script of Part IV, for distribution to personnel.

February 1977

PROJECT NUMBER: SED 74-17717 **AMOUNT AWARDED:** $46,600

DATE AWARDED: June, 1974 **DURATION:** 14 months

PROJECT TITLE: SELECTED PROBLEMS IN DESIGN OF AIR POLLUTION CONTROL EQUIPMENT

PROJECT DIRECTOR: Dr. Louis Theodore

PROJECT ADDRESS: Manhattan College
Bronx, New York 10471
(212) 548-1400

PURPOSE:

The objective of this workshop was to develop an "Air Pollution Control Equipment Problem Workbook". Problems and solutions were generated by an environmental, but interdisciplinary, team of faculty. Topics included: absorption, adsorption, combustion, condensation, dilution, fluid-particle dynamics, gravity settlers, cyclones, electrostatic precipitators, filters, and venturi scrubbers.

AUDIENCE:

The problem workbook was primarily developed for undergraduate engineering and science students.

INNOVATION:

In the last two decades, the engineering and science professions have expanded their responsibilities to society to include the control of both gaseous and particulate pollutants from industrial sources. Increasing numbers of engineers and applied scientists are today confronted with problems in this emerging field. In an attempt to meet this challenge, educators have introduced, or are in the process of introducing into engineering curricula, courses on industrial control equipment; and the need for a problem-oriented workbook in this area of study has become apparent in recent years. The lack of meaningful problems available to educators has hampered the development and presentation of a modern, up-to-date course in this very important area.

EVALUATION:

To help develop and maintain effective lines of communication between the participants after the workshop was completed and the workbook developed, and at the same time monitor the success of the program, each educator was requested to submit a short report to the Project Director some time before the end of the summer in 1975.

This report would outline classroom impact and student feedback, and help identify positive and negative factors resulting from participation in the workshop. A summary of these reports was to be prepared and distributed to the participants soon after receipt of the reports. No reports had been received at the time of the preparation of this announcement.

MATERIALS:

The staff and participating faculty decided, with NSF approval, to publish the workbook through the National Technical Information Service (NTIS). The NTIS accession number is PB 246 363/AS (use this number if ordering); the papercopy and microfiche prices are $11.00 and $2.25, respectively.

PROBLEMS:

No major problems were encountered.

ADDITIONAL COMMENTS:

In general, the ability to design or predict performance of industrial equipment for both gases and particulates requires an understanding of fundamentals as well as practical considerations. The collection mechanism for atmospheric pollutants is substantially more complex than that for water systems and not very well understood. Current design practice for gaseous and particulate control equipment is strictly state-of-the-art and pure empiricism. Little is available in the literature. This can no longer be tolerated in light of the need for reliable higher collection efficiency equipment. In view of present day knowledge, the need for the presentation of fundamentals and the development of a problem-oriented workbook should aid both the educator and student.

A wide variety of applications were reviewed in the workshop - with particular emphasis on industrial problems. Lectures on selected topics in air pollution were given by acknowledged experts in this field. Gaseous pollutant control equipment reviewed included: absorption, adsorption, condensation, combustion, and dilution. Particulate control equipment topics studied encompassed: fluid-particle dynamics, gravity settlers, cyclones, electrostatic precipitators, venturi scrubbers, and filters. The workshop group was able to generate at least fifteen meaningful applications-oriented problems and solutions for each control device during the first summer session.

The 1974-75 academic year provided an opportunity to classroom-test the effectiveness of the problems in the workbook The two-week follow-up summer session in 1975 was scheduled to provide an opportunity to revise, update and edit the workbook, and finalize production and distribution plans for implementation in undergraduate science curricula.

February 1977

PROJECT NUMBER: SED 70-03352 AMOUNT AWARDED: $ 1,992,037

DATE AWARDED: May 18, 1971 DURATION 6 years

PROJECT TITLE: EDUCATION AND EXPERIENCE IN ENGINEERING (E^3) PROGRAM

PROJECT DIRECTOR: Dr. T. Paul Torda

PROJECT ADDRESS: E^3 Program Center
Illinois Institute of Technology
Chicago, Illinois 60616
(312) 567-3190

PURPOSE:

The program is designed to achieve two major objectives:

Education of engineers to high level interdisciplinary competence so that they may be able to solve problems within technological, sociol-economic, legal, and other constraints.

Achievement of proper motivation for students to obtain this high educational level.

The four year undergraduate interdisciplinary engineering program leads to the Bachelor of Science in Engineering degree. Besides being interdisciplinary in the sense that students are studying in most branches of engineering (mechanical, civil, electrical, chemical, environmental, etc.), the studies extend beyond the technological fields into social sciences and humanities.

All studies are carried out within the context of projects which are conducted by small groups of students (4 to 6, one from each academic year) with faculty members (one from engineering or physical sciences and another from social sciences or humanities) as adviser-consultants. All E^3 projects cover problems which are socially significant as well as important in the technological sense. The projects are selected by students and faculty and serve to motivate students to learn in depth material needed to solve the problem at a high level of sophistication. Self-paced instruction is used throughout instead of classroom instruction and, in all learning and performance, mastery of the material is required.

Students work in small groups and learn to lead a project as well as to be team members. A student (usually an upperclassman) is in charge of the project instead of a faculty member. Also, a "senior project" is required for graduation in which the student is in charge from inception through completion of a project.

AUDIENCE:

The program is designed for undergraduate engineering students as a unified curriculum. It has also proven useful for people working in industry in continuing their education to obtain a degree (evening and weekend studies). Although not an honors program, it is designed for students who are able and willing to take the responsibility for their education. The philosophy and methodology developed for E^3 are applicable to other professional educational programs.

INNOVATION:

The program is developed to educate self-initiating, self-pacing, and self-evaluating professional engineers. Instead of classroom-laboratory format, the project group takes over scheduling and learning motivation.

Tried and proven philosophy and methodology are integrated into a new and radically different undergraduate engineering program. Self-paced instructional material has been developed to be used in a new way, in that the material, though having prerequisites, is developed in independent units, the "learning modules." Basic knowledge, usually learned during the first two years of college in conventional engineering curricula, is acquired by means of the learning modules. More professional material, covered in the junior and senior years in conventional curricula, is learned by means of directed and independent study using the library as a resource and relying heavily on professional material published in current journals, books, proceedings, etc. This mode of successively weaning the student from the lockstep learning method allows for professional growth and creates skills for continuing learning after graduation.

EVALUATION:

Evaluation occurs on two fronts: student evaluation and program evaluation.

Evaluation--Student

For E^3, student evaluation and program evaluation assume importance that they do not have in well-established curricula. Because of its innovative characteristics, the Program has found it necessary to re-examine traditional concepts of student evaluation and to reject some as inappropriate to the E^3 setting. The goals indicate that students should be able to undertake self-evaluation with which they can be comfortable and confident. Hence evaluation in the Program is principally formative. (One obvious departure from convention is the absence of grades other than "M". The "M" grade is not a substitute for "Pass" in the "Pass-Fail" system. Its closest grade equivalent is B+ and better.) Day-to-day evaluation is provided by peers and faculty in the project teams. Such daily evaluation is not common in traditional undergraduate programs and requires skill in providing effective but not destructive criticism by students and faculty.

The student/faculty Review Board exercises final judgment to accept or reject project proposals and reports and, hence, serves as a more formal source of evaluation. The Board meets with the teams regularly to make such formal evaluations and suggestions.

Semesterly evaluation is initiated by the students. At the end of a project, each student files a credit request, indicating the number of credits he/she anticipates, and the distribution of those credits in three areas: Professional/Project (PP), Humanities and Social Sciences (HSS), and Mathematics, Science, and Engineering Sciences (MSES). Self-paced study (Learning Modules) and seminars have preassigned credit for work done at the mastery level, and students easily document their achievements in those activities. For project work, the team generally works out its credit requests and documentation as a group.

The final report and presentation are assessed by the Review Board and the Board either authorizes the credit requests as they stand or makes adjustments in consultation with the team as a whole.

Evalution--Program

The E^3 Program has had three sources of external evaluation. The first was the Board of Advisers, ten prominent people drawn from industry, government, and higher education, all of whom have engineering or engineering educational backgrounds, and who have made substantial contributions to their various fields. The Board of Advisers, through semi-annual visits to the Program, reported on overall progress of the Program, and made recommendations to help the Program achieve its goals. It met with faculty, students, and IIT administration, and received written materials in advance of its visits. It submitted reports to the Program, which in turn, forwarded the reports to the National Science Foundation and the IIT administration.

During the first two years of implementation, the Program was evaluated by the Center for Instructional Research and Curriculum Evaluation (CIRCE) at the University of Illinois, Champaign-Urbana. CIRCE is affiliated with the Department of Educational Psychology and was charged with evaluating the Program from that viewpoint. At the recommendation of the Board of Advisers and the National Science Foundation, this evaluation was discontinued after two years and an internal evaluation process was initiated. This process focused on attitude changes and the growth of students who successfully completed E^3, and used both questionnaire and interview techniques administered to all students who enrolled in E^3 whether "successful" or not. A partial interim report has been prepared and a final one will be ussued in May 1977.

The third source of "external" evaluation of the Program is the IIT Faculty Curriculum Committee Subcommittee on E^3. This subcommittee is charged by the President of IIT with evaluating the Program as an IIT degree granting program. The Subcommittee examines the Program for consonance of its standards with those of other engineering programs of the Institute.

Credentials and Recognition of E^3 Students

As students do not receive grades, employers and graduate schools cannot receive grade point averages, traditional, if limited, indicators of student "quality." In the E^3 Program, much more extensive records of student progress are kept than are kept in conventional curricula. These records and documents are collected by the students into portfolios. The portfolio shows not what courses and grades the student has, but rather what he/she has done while in the Program. While this may pose some difficulties for the early stages of recruitment interviews and graduate school applications, it does not appear to have posed insuperable problems for the graduates of the Program.

The Bachelor of Science in Engineering, a new IIT degree awarded only to graduates of the E^3 Program, has been approved by the faculty in recognition of the quality of the Program and its graduates.

The graduates have not experienced difficulties in entering prestigious graduate schools or employment of their choice (with high starting salaries, based on national averages).

Credentials and Recognition of the E^3 Program

At this stage, it is difficult to make hard statements about recognition. However, several signs appear encouraging. The Board of Advisers has made uniformly favorable recommendations to NSF, IIT and the E^3 Program Center. The recommendation to discontinue the outside evaluation effort of CIRCE was made on the basis of rigorous and comprehensive internal E^3 evaluation efforts.

The Program has produced several publications, received many requests for articles and reports, given workshops and invited addresses, and had many visitors from across the United States. On the international level, visitors, requests for materials, and invited seminars indicate international interest in the Program. Though not accredited at this stage, the ECPD visiting team declared E^3 "accreditable" based on academic standards, faculty and student devotion, and student achievements.

MATERIALS:

Approximately 650 learning modules have been prepared within the framework of the Program. These learning modules cover all the "core" material (material learned during the freshman and sophomore years in conventional engineering curricula) and correspond to 21 courses representing approximately 71 credit hours of work. These learning modules follow standard engineering courses, but are composed such that they are as independent of each other as possible, and while naturally each has prerequisites, they are self contained study units. Having been revised several times after evaluation by students and faculty, they are being printed in final form and are available on a cost basis as final typing and printing proceed--from the E^3 Program Center.

PROBLEMS:

At first, the Program was "tolerated" by the faculty in spite of strong support by the Dean of Engineering and Physical Sciences. Later, faculty accepted E^3 as a regular program at IIT in spite of severe criticism by a small but outspoken group, a subcommittee of the Curriculum Committee. Although the president strongly supports the Program, due to precarious financial conditions, the original funding committed to NSF by IIT for last year was considerably reduced. Though the remaining funds from NSF--originally designated for final development of the Program but transferred to cover operating expenses--helped considerably, the severe cuts in finances meant reduction of full-time equivalent (FTE) faculty from the needed 8½ to 6. This prevented the E^3 administration from finishing many of the efforts this successful program needed. The recently released budget for faculty salaries for the coming academic year means crippling cuts for the Program in spite of the expected increase of enrollment.

Closing Comments

It is appropriate to make a few informal comments about the Program at this point. The E^3 Program is a response to various social and educational stimuli at mid-century. It is not intended as a panacea for engineering education, nor is it likely that it will be (or should be) adopted part and parcel by other colleges and universities, where conditions and goals are likely to be different. The hope of the E^3 Program is that it will serve to encourage others to undertake those innovative techniques and programs which are appropriate to their own situations and to offer any assistance that we can provide.

Changes in societal and global needs require rethinking of conventional educational methods and philosophy. The E^3 Program supplies a (by now) tried new way to make education a meaningful experience to both responsible full-time undergraduates and working persons wishing to continue their education towards a degree.

PROJECT NUMBER: SED74-17713 AMOUNT AWARDED: $55,290

DATE AWARDED: May 22, 1974 DURATION: 18 months

PROJECT TITLE: AN EXPERIMENTAL ENGINEERING TECHNOLOGY CAREER PROGRAM FOR DISADVANTAGED MINORITY STUDENTS

PROJECT DIRECTOR: Theodore P. Vassallo

PROJECT ADDRESS: Temple University
College of Engineering Technology
Broad St. & Columbia Ave.
Philadelphia, Pa. 19122
(215) 787-7803

PURPOSE:

The purpose of this project is to interest disadvantaged minority students for careers in the field of engineering and engineering technology and to encourage the upward mobility of minorities. We expect that students who complete this program will be strongly motivated towards careers in engineering and engineering technology and may wish to enroll in engineering curricula offered by Colleges and Universities throughout the country.

AUDIENCE:

The project is intended to take minority disadvantaged students in the Philadelphia Inner City Schools who have completed the ninth year in high school. Fifteen students are selected to participate in a summer career workshop. Three workshops are planned; two of which were conducted during the summers of 1975 and 1976. It is expected that other Universities may want to conduct similar career workshops to inform students of the opportunities in the field of engineering and engineering technology.

INNOVATION:

The experimental project is a joint effort of the College of Engineering Technology, the Philadelphia School District, and several local industrial firms who employ engineering personnel.

The project is divided into three phases covering a period of three years for each participating group. Three groups will participate in the program two of which were involved in summer career workshops during the summer of 1975 and 1976.

There are three phases in the experimental project.

1. Phase One - Summer Career Workshop-
   A career workshop is conducted during the summer by the faculty of the College of Engineering Technology. The sessions are held in the College of Engineering Technology of Temple University four days a week for a six weeks period beginning in July and ending in August. Fifteen students both male and female are

are recruited from the Philadelphia Inner-City schools to participate in the summer career workshop. The workshop sessions commence at 8:30 A.M. and dismiss at 12:30 P.M. They cover electrical, mechanical, civil and environmental engineering concepts.

2. Phase Two - High School Participation
During the period when students are attending their regular high school, professional counselors from the School District Mathematics Office and from each school will counsel and guide them relative to problems of an academic, financial and personal nature.

Three follow-up sessions are conducted on a Saturday during the academic year for those students who completed a summer career workshop. These involve hands-on laboratory sessions in electrical, mechanical and civil engineering areas.

3. Phase Three - Industry Cooperation
Local industry has agreed to supply jobs during Phase Three Activity - the summer work period for each participating group. This is to provide on the job experience related to engineering applications.

The Coordinator of Industrial Relations at the College of Engineering Technology visits these students on the job and checks on their experiences. Each student submits a written report at the end of his work experience to the Coordinator of Industrial Relations.

The supervisor in the local industrial firm will also submit an evaluation report of the student's progress during the work period.

It is expected that this project will provide a means to motivate and interest other minority disadvantaged students to careers in engineering and engineering technology.

EVALUATION:

Phase One is evaluated by the faculty which conducted the summer career workshop. Phase Two is evaluated by the Philadelphia School District representatives. Phase Three is evaluated by the participating industrial firms. An independent evaluator will condcut an overall evaluation including student evaluation of the experimental project.

MATERIALS:

When the project is completed a final report will be made available to the various local high schools, colleges and universities, industrial firms, governmental agencies, and several interested community groups.

PROBLEMS:

A major problem which developed was the inability of the various local industrial firms to provide jobs for the participating students during the summer. Only half the students were employed by industry. Some of the reasons given for not providing jobs were; budgetary cuts, insurance problems especially with 15 year old students, and inability to provide proper supervision.

We resolved this difficulty to some degree by providing work experience in the College of Engineering Technology at Temple University supervised by a professional engineer.

ADDITIONAL COMMENTS:

While the project has not been completed, the evaluation reports submitted to date indicate that we are making real progress in achieving our objective.

February 9, 1977

PROJECT NUMBER: SED 75-01422 **AMOUNT AWARDED:** $86,900

DATE AWARDED: June, 1975 **DURATION:** 18 months

PROJECT TITLE: DEVELOPMENT OF A CURRICULUM IN RESOURCE RECOVERY

PROJECT DIRECTOR: P. Aarne Vesilind

PROJECT ADDRESS:
Department of Civil Engineering
Duke University
Durham, North Carolina 27706
(919) 684-2434

PURPOSE:

The use of municipal solid waste as a source of materials and energy is a necessary component of future urban society. It is the purpose of this project to develop a curriculum to train the engineers of the future in the field of materials and energy recovery. This curriculum, once established, will be transplanted to other universities.

AUDIENCE:

The immediate recipients from this project are the engineers who will receive an education in a rapidly emerging and vitally important field. The secondary beneficiaries are the municipalities, states, consulting firms, and private corporations who will require the skilled manpower to carry out the resource recovery plans.

INNOVATION:

The field of resource recovery is only now emerging, and no core of literature or textbooks exist to allow for ready adaptation to classroom use. As part of this project, a compendium entitled "A Curriculum Option in Resource Recovery Engineering" has been prepared for distribution. The compendium contains information and instructional aids which has organized the field of resource recovery into a coherent structure. The compendium is divided into four sections. The first three sections contain descriptions of the three resource recovery courses offered at Duke:

- Solid Waste and Resource Recovery Engineering
- Resource Recovery Systems Management
- Materials Design and Conservation

Included in these descriptions are outlines, objectives, suggested texts, projects, and source material not usually found in existing textbooks and available publications. The content of this material includes topics such as a review of the historical roots of resource recovery, the analysis of unit operations, materials properties significant in resource recovery operations, littering studies, and descriptions of innovative materials separation processes.

The last section contains a self-instructional cassette tape/workbook module and seventeen slide sets. The slide sets are on the following topics:

- Collection Safety
- Auto Shredding
- Collection Technology
- Incinerators
- Composting
- Union Electric/St. Louis
- Hazardous Wastes
- Landfills
- NCRR/Washington
- Black-Clawson/Franklin
- Wheelabrator-Frye/ Saugus, Massachusetts
- Monsanto/Baltimore
- Bureau of Mines/Washington
- Burning Bagasse in Hawaii
- Occidental/San Diego
- Union Carbide
- Low Technology Recycling/ Weston, Massachusetts

In all, the compendium contains over 300 pages, 18 drawings designed for overhead projector transparencies, one cassette and workbook, and 136 2x2 slides.

EVALUATION:

All people who were initially contacted when the study was being developed were asked to comment on our plans and progress. Once the compendium has been distributed, we have asked educators who use the material to provide a written evaluation of the material provided.

MATERIALS:

All of the materials involved in this project were developed internally. Educators interested in using this material for the development of courses in resource recovery may obtain a copy of the compendium by writing to the Duke Environmental Center, clearly stating their intent in using the material for courses in resource recovery engineering.

PROBLEMS:

None.

ADDITIONAL COMMENTS:

None.

February 1977

PROJECT TITLE: COMPUTER INSTRUCTIONAL AIDS FOR UNDERGRADUATE CONTROL EDUCATION

PROJECT DIRECTOR: Richard A. Volz

PROJECT ADDRESS: Department of Electrical and
Computer Engineering
The University of Michigan
Ann Arbor, Michigan 48104
(313)763-0035

PURPOSE:

The purpose of this project was to develop a set of computer analysis and design programs for control systems which could be integrated into a basic undergraduate control sequence and which utilized heavily computer graphic capabilities. To provide the student with a comprehensive view of what can be accomplished with computer aids the system developed was to include the operations appropriate to elementary control courses and to illustrate the advantages of both digital and hybrid computation.

AUDIENCE:

The material developed was intended for use in undergraduate courses in automatic control theory. Thus far, the digital programs developed have been used in the basic undergraduate control course and in an associated laboratory. The hybrid system developed is used as the basis for about 60 percent of the laboratory work and is also used in a course Dynamic Systems and Modelling. Both have been used on an irregular basis for demonstration in other courses.

INNOVATION:

There are two aspects to the work developed, a time-shared hybrid control system simulator and a set of digital computer aided design programs each of which operate from graphic terminals. The former is built around the use of a single general configuration control system programmed in a time-shared manner on a hybrid computation system. A wide variety of specific systems can be obtained by selectively zeroing unneeded portions of the system. Student users operate from graphic terminals and select from among predefined problems those which they wish to study. Parameters in these may be varied from the terminals and the responses observed. Typical response time is on the order of a few hundred milli-seconds.

The digital phase of the work has been dubbed COINGRAD (Control Oriented Interactive Graphic Control Analysis and Design) and encompasses time response, frequency responses and root locus calculations. Though intended primarily for interactive use through a graphics terminal such as the Computek or Tektronix terminals, the program will function from standard teletype terminals or in batch mode. They operate with a simple command structure through which the student can enter his program description in as close to natural language as possible, and simply ask for the solutions he desires. In addition a limited optimization capability is included.

EVALUATION:

No formal evaluation of the utility of the computer projects themselves was conducted. However, some feedback is obtained from course evaluation forms and informal feedback from students was sought. In general, except for the occasional hardware failures, the programs have been well received.

MATERIALS:

Copies of the source code for all digital programs developed and the analog and logic diagrams for the hybrid functions are available from the principle investigator. A FORTRAN IV version of COINGRAD including graphics routines is now available. Also, a movie illustrating the hybrid simulator is available for loan.

PROBLEMS:

Other than the usual debugging problems which arise, the items which have been noted are:

1. Hardware failures. This has occurred with both the hybrid system and the digital terminals. Diagnostic programs usually allow the hybrid problem to be found without too much delay and remedied by component replacement. These problems usually are the

result of improper use of the hybrid equipment by students in other courses. Occasionally noise on the data lines causes difficulty. Failures on the digital terminals and hard copy unit have been particularly annoying, with repairs often taking several weeks, due to the delay in getting replacement parts.

PROJECT NUMBER: SED 74-19579 **AMOUNT AWARDED:** $40,420

DATED AWARDED: 1 July, 1974 **DURATION:** 16 months

PROJECT TITLE: EDUCATIONAL IMPROVEMENT PROGRAM IN ENTOMOLOGY

PROJECT DIRECTOR: Vernon J. Tipton

PROJECT ADDRESS: Brigham Young University, Provo, Utah 84602
801-374-1211 Ext. 3839.

PURPOSE:

This was an experimental project designed to improve the teaching of entomology in colleges and universities throughout the United States. There were three major thrusts: to provide greater access to education materials for entomologists (Catalog of Instructional Materials for Entomology), to improve their basic teaching skills (an auto-tutorial inservice training course consisting of a manual and a companion cassette both of which were entitled "Toward More Effective Teaching"), and to bring about a balance between teaching and research in the annual meetings and publications of the Entomological Society of America.

AUDIENCE:

Entomologists at educational institutions charged with the responsibility of teaching entomology.

INNOVATION:

The innovative character of the project resides in the attempt to bring about change in an organizational structure and to emphasize the importance of teaching to a group of research oriented professional entomologists.

EVALUATION:

Each of the three aspects of the project were evaluated with an instrument developed by professional educational researchers. Feedback from the evaluation instruments were used to improve and update the catalog and to make recommendations to the officers of ESA regarding annual meetings and publications. The project served to focus attention on the need for an administrative mechanism within the organizational framework of ESA which would foster the improvement of teaching. The governing board of ESA is currently reviewing recommendations concerning the role of the Committee on Education.

MATERIALS:

Toward more Effective Teaching (a manual and a companion cassette). Catalog of Instructional Materials.

PROBLEMS:

There yet remains a need to find a way to update the Catalog and to inform entomologists of materials available for teaching this specialized and important area of biology. In addition, continued pressure must be applied to the governing board of ESA to bring about a change in attitude among the professional membership regarding the importance of teaching.

PROJECT NUMBER: SED 71-04418 AMOUNT AWARDED: $86,694

DATE AWARDED: November 17, 1971 DURATION: 12 months

PROJECT TITLE: DEVELOPMENT OF A NEW INTERDISCIPLINARY EARTH SCIENCE COURSE

PROJECT DIRECTOR: Addison E. Lee

PROJECT ADDRESS: Science Education Center
The University of Texas at Austin
Austin, Texas 78712
(512) 471-7354

PURPOSE:

The purpose of this project was to develop a new course which involved the preparation of a series of multi-media introductions to specific environmental problems. Materials for the course included a series of self-directed learning sound-slide lessons including laboratory activities and plans for small group discussions and large group synthesis lectures.

AUDIENCE:

The course is being offered in the Department of Geological Sciences and is listed as an upper division course. The course attracts students from a wide range of backgrounds particularly prospective secondary and elementary science teachers and others including those with interdisciplinary interests. It was expected that the course be offered not only at The University of Texas at Austin but would serve as a model for the offering of similar courses using the same or similar materials at other colleges and universities interested in the interdisciplinary approach.

INNOVATION:

Innovations developed for the course are in its pattern of organization, its development of sound-slide lessons to be used in an individualized learning format, in small group discussions and its synthesis lectures in which the professor puts together in a single presentation the important points from the individualized learning lessons and the group discussions.

To provide for the individualized learning lessons, individual carrels were designed in which the sound-slide presentations were housed for a given period of time to be used by students on an individualized basis. Aid in the design of these carrels was provided by members of the faculty in the School of Communications. For each lesson, a student was provided with a study guide and a copy of the script for the sound recording. The carrels can be used by either one or two students and allow for student interaction as well as laboratory work that has been built into each individualized lesson. The sound tapes and slides have been synchronized so that there is an automatic change from one slide to another as the sound tape is heard.

Duplicate versions of the individualized lessons also have been prepared with audible signals on the sound tape so that the lessons can be used in group lessons if individualized lessons are not preferred.

EVALUATION:

Evaluation of the project was carried out in several ways. The course was initially tried out as a departmental offering and feedback obtained from students taking the course. Individual components of the course were then revised and the course again offered for additional feedback and revisions. Scripts of the individualized learning lessons were reviewed and edited by selected members of the education faculty who provided suggestions for modifications in the several revision steps.

In addition to the evaluation described above, a formal evaluation was undertaken by a graduate student. This study "The Analysis of Students Reactions to Audio Visual Tutorial Geology Lessons" by John David Keller was developed as a doctoral dissertation. Results from this study were used in the final revision of the lessons.

In the Fall of 1976, a conference was held in the Science Education Center attended by a group of college earth science teachers from this region. The participants were shown the materials developed and asked to evaluate them in terms of their potential for use in their own teaching.

MATERIALS:

The complete program includes a set of lecture notes for the professor and 15 learning carrel lessons as follows:

Section I: Man's Effect on Nature

Lesson 6.1 - Population
Lesson 6.2 - Land Use
Lesson 6.3 - Urban Crisis (Field Trip)

Section II: Energy

Lesson 6.4 - Energy
Lesson 6.5 - Energy Resources
Lesson 6.6 - Future Projections

Section III: Processes Through Time

Lesson 6.7 - Geologic Time
Lesson 6.8 - Long Term Events
Lesson 6.9 - Short Term Events

Section IV: Natural Resources

Lesson 6.10 - Minerals
Lesson 6.11 - Conflicts of Interest
Lesson 6.12 - Soils
Lesson 6.13 - Water

Section V: Oceanography

Lesson 6.14 - Ocean Resources
Lesson 6.15 - Pollution of the Oceans

Each learning carrel lesson consists of a set of two by two slides, an audio cassette tape, a study guide and a script for the audiotape. The slides are housed in a carrousel and the study guide and script are put together in a booklet.

The learning carrel lessons and lecture notes are available for inspection in the Science Education Center at The University of Texas at Austin. We have made duplicate sets of these materials and will try to work out arrangements so they can be seen here or under certain circumstances borrowed by faculty members in other colleges and universities that might wish to use them as a model for developing their own programs. At this time, we have made no arrangements for commercial distribution of these materials.

PROBLEMS:

The principle problems in carrying out this project have been in locating and securing the services of individuals with appropriate expertise in the making of sound-slide lessons. We have used both faculty members in the Department of Geological Sciences and in the Science Education Center as well as graduate students from these areas to develop the content material for these lessons. This arrangement has worked fairly well so far as getting appropriate content material; however, it has often been delayed and deadlines have not been met because of pressures on these academic people. This situation has caused us to miss several deadlines in the completion of the project.

ADDITIONAL COMMENTS:

On the whole we feel that the project has been extremely successful. The feedback and other evaluation efforts have resulted in very positive acceptance of the program by the students who have used it and the college faculty participants at our conference who saw the lessons.

February 1977

PROJECT NUMBER: SED75-10694 AMOUNT AWARDED: $73,541.00

DATE AWARDED: February 1, 1975 DURATION: 27 months

PROJECT TITLE: ENVIRONMENTAL EDUCATION FOR SCIENCE TEACHERS (Atmospheric Pollution)

PROJECT CO-DIRECTOR: Donald R. Rowe

PROJECT ADDRESS: Department of Engineering Technology
Western Kentucky University
Bowling Green, Kentucky 42101

PURPOSE:
The first objective of this project was to provide elementary, junior and senior high school science teachers with instruction in the fundamental concepts of the various kinds of environmental pollution and their control. Specific emphasis on this portion of the project dealt with atmospheric pollution. The second objective was to develop video tapes and accompanying scripts as well as lesson plans and resource materials for classroom use. The third objective was to implement this project on a state-wide basis through cooperation with other state universities and institutions.

AUDIENCE:
The lesson plans and resource materials were aimed at the elementary, junior, and senior high school level students while the video tapes and scripts were for use in introducing the high school science teachers (or health-oriented teachers) to environmental education in atmospheric pollution.

INNOVATION:
This program was designed for science and health-oriented teachers who have the necessary contact and capacity to relay the information and techniques to a large segment of the public school population. Also by utilizing the science teachers in the preparation of the lesson plans and resource materials, the proper level and appropriate organization of these units could be achieved.

EVALUATION:
The video tapes and accompanying scripts have been evaluated at various presentations for the science teachers and by undergraduate students at Western Kentucky University. Changes and refinement of this material is presently underway. Evaluation of the lesson plans and resource material has not been carried forward due to termination of the project.

MATERIALS:
Thirty-four units or lesson plans were prepared by the science teachers, of which twenty-nine have been edited and are ready for distribution.

Ten half-hour video tapes and accompanying scripts have been prepared and are ready for distribution. Following is a list of the units, and video tapes and scripts.

Units: Prepared by teachers.

1) James Ella Drake: Air Pollution Effects on Man's Health; Air Pollution Effects on Vegetation; Air Pollution Effects on Materials; and Air Pollution Effects on Animals.
2) James Constant: Automotive Emission Control; Photochemical Oxidants; Sampling & Monitoring for Automotive Emission; Radiation in the Atmosphere.
3) Mary Frank Hendershot: SO_x, NO_x, and O_x; Atmospheric Dispersion Computer Program; Sampling and Monitoring for SO_x, NO_x, O_x.
4) Samuel M. Mashburn, Jr: Lichens - Indicators of SO_2 Air Pollution; Personal Air Pollution: Cagarettes, Cigars, Pipes; Economic Incentives for Air Pollution Control; Measurement and Control of Some Objectionable-Odor in the Community.
5) Stephen A. Mayhew: Meteorological Fundamentals Dealing with Air Pollution; Scales of Motion; Air Pollution and Climate: Urban Effects on Meteorological Parameters.
6) Mildred F. Pile: Air Pollution Control: Stationary Sources (Gravitational, Wet Collectors, Fabric Filters, and Electrostatic Precipitators); Air Pollution Legislation.
7) John Purwin: Particulate Matter; Sampling Particulates: Hi-Vol Sampler and Paper Tape Sampler.
8) Doris N. VanCleve: Sources of Air Pollution; Emission Inventory; Slide Presentation "Air Pollution."
9) Henry N. Williamson: Characteristics, Occurrences and Effects of Carbon Monoxide in the Atmosphere; Measuring, Controlling & Regulating CO in the Atmosphere; The Characteristics, Occurrences and Effects of Hydrocarbons in the Atmosphere; Computer Science Application to Solving Air Pollution Problems for Secondary Students (Air Pollution Index).
10) Jackie M. Young: What is Air Pollution? History and Episodes; Federal Programs for Control of Air Pollution; Hazardous Pollutants.

Scripts and Video Tapes: Prepared by D. R. Rowe. (Instructional Media Resources, 1976: Western Kentucky University, Division of Media Services.)

1) "Introduction to Air Pollution" Tape No. 3-30-290 (20 Minutes)
2) "Atmospheric Self-Cleansing Process and Preparation of an Emission Inventory" Tape No. C-30-182 (30 Minutes)
3) "Particulate Matter" Part I: Tape No. C-30-378 (30 Minutes)
4) "Particulate Matter" Part II: Tape No. C-30-379 (30 Minutes)
5) "Carbon Monoxide" Tape No. C-30-213 (30 Minutes)
6) "Oxides of Sulfur" Part I, Tape No. C-30-405 (30 Minutes)
7) "Oxides of Sulfur" Part II, Tape No. C-30-415 (30 Minutes)
8) "Oxides of Nitrogen" Tape No. C-30-414 (30 Minutes)
9) "Meteorology and Air Pollution" Part I, Tape No. C-30-413 (30 Min.)
10) "Meteorology and Air Pollution" Part II, Tape No. C-30-416 (30 Min.)

PROBLEMS:
The most serious problem encountered was the loss of funding by the National Science Foundation owing to a Congressional prohibition of support for implementation.

ADDITIONAL COMMENTS:
This project essentially started in 1972 on a trial basis with support from the Kentucky Lung Association and Western Kentucky University. Science teachers, mainly from Louisville, Bowling Green and Owensboro participated. The program was offered in Owensboro in the spring of 1976 and thirteen science teachers participated. Plans were underway to start the program in the eastern part of the state at Pikeville College; however, this had to be suspended due to cancellation of funding. The atmospheric pollution course will be offered at Western Kentucky University approximately every two years.

PROJECT NUMBER: SED64-00021 AMOUNT AWARDED: $189,850

DATE AWARDED: June 19, 1975 Duration: 30 months

PROJECT TITLE: SPATIAL ANALYSIS OF LAND USE

PROJECT DIRECTOR: John F. Lounsbury

PROJECT ADDRESS: Geography Department
Arizona State University
Tempe, Arizona 85281
Phone No. (602) 965-3471

PURPOSE:

The primary objective of this project is the development of a master's degree program emphasizing applied research as it pertains to the spatial analysis of land use. Conventional academic programs, in general, have not kept pace with recent advances in technology and subject matter, nor the rapid increase of land use problems and issues at the micro-, meso-, and macro-scales. The project is designed to bear upon these problems.

The program focuses on: (1) techniques concerned with the acquisition of land use and related data; (2) methods of data processing and analysis and communication of information; (3) institutional and other frameworks for land use decision-making; and (4) formulation of research design concerned with spatial analysis. Emphasis is on the contribution which the application of geographic research methodologies can make to the realization of these program objectives. This research specialization prepares program graduates for applied research in positions at the operational and policy levels in Federal, state, and local governmental agencies and private firms and consulting agencies as well as doctoral work in this area. Although the program is designed to enable students to specialize in a specific area of applied research, its focus on modern research methods will soundly prepare students to engage in doctoral work in other areas or subfields of the discipline.

AUDIENCE:

The program is being developed by the cooperative efforts of three universities: Arizona State University, Florida State University, and Michigan State University. For the first year of the instructional program (1976-1977 academic year and the summer of 1977), a maximum of eight students were admitted formally at each of the participating institutions. Students were selected from a national pool of applicants. Three to five fellowships at each university were made available from university and private foundation sources for students enrolled in the program. In subsequent years, larger numbers of students will be accepted.

Further, it is intended that the developed program will serve as a model to be adoped, in part or in total, by other universities and colleges. It is hoped that the program will be recognized by Federal, state and local agencies as well as private firms and consulting agencies as viable and sound training for persons to be employed at the operational or policy levels dealing with land use analysis.

INNOVATION:

The project is innovative in that three universities are working closely together in the program development. Although the program is based in the Geography Departments in each of the three institutions, relevant expertise in other academic units and divisions of the universities are fully utilized. Further, the participation of the three institutions, each located in a distinctly different geographical area and environment, insures a national perspective, enhances the possibilities of the program being adopted by other institutions, and provides a mechanism to utilize the combined resources of the three cooperating universities. The program is a major new option in the existing Master of Arts degree programs at each institution.

Another innovative feature of the project was the bringing together of individuals from academic institutions with those, involved daily with policy issues, to jointly develop the program. The concepts, subject matter, and special skills, around which the program was structured, were identified during the planning period (1975-1976 academic year) through the close working arrangement of Faculty Developers, three to four from each university, and an Advisory Committee comprised of nationally prominent individuals, most of whom are presently associated with private or governmental agencies. The members of the Advisory Committee represent a wide diversity of land use interests and professional training - law, planning, land management, area development, urban affairs, agriculture, and real estate development and finance.

EVALUATION:

While the instructional program is underway (1976-1977 academic year and the summer of 1977) internal evaluation will determine how well the program concepts and skills are dealt with, both from the course content and presentation standpoints. The Advisory Committee also acts as an informal evaluation team throughout the lifespan of the project.

Further, it is felt that the success of the program can be best measured by the quality of the professional work and competence of the program graduates in actual on-the-job situations. In view of this objective, formal evaluations will be made approximately six months after each individual student has been graduated and employed. These evaluations will include: the student's opinion of the program and its relevancy to the position he is currently holding; the employer's opinion of the student's training and motivation as well as his contribution to the overall professional tasks in which he is engaged; and former students of each department who are now employed in responsible land use positions. The results of the evaluation will be utilized to modify and improve the instructional program.

MATERIALS:

A printed booklet describing the program, objectives, goals and course offerings, including a detailed outline of each of the courses, will be prepared and distributed to all pertinent academic departments and will be available upon request to other groups or individuals.

PROBLEMS:

Essentially, the development of the program consisted of the rigid evaluation and redesigning of pertinent existing courses; the development of new courses; and the combining or repackaging of courses and experiences to improve and modernize the applied research training of graduate students specializing in land use analysis. This development required the close cooperative and participation of faculty, administrators, academic and non-academic units of the universities not directly associated with the project. Problems revolving around the development of a major new option within the graduate programs, lack of knowledge or confused ideas about the objectives of the program, and initiating drastic necessary changes in the curriculum structures arose at each of the institutions. These problems were anticipated and resolved in meetings designed to educate and develop lines of communication.

Anticipated problems in the future are concerned with the adoption of the program, in total or in part, by other institutions and the recognition of the program by potential employment agencies. The transferability of the program would be expedited by publishing pertinent course materials and organizing regional workshops in the near future. The development of a printed booklet describing the program, designed for and distributed to potential employers, would be of help in effecting the recognition and acceptance of the program.

February, 1977

PROJECT NUMBER: SED73-10499 A03

AMOUNT AWARDED: $ 72,700

DATE AWARDED: 17 May 1976 DURATION: 24 months

PROJECT TITLE: TEACHER DEVELOPMENT IN PH.D. PROGRAMS IN GEOGRAPHY

PROJECT DIRECTOR: William D. Pattison

PROJECT ADDRESS: Department of Geography
University of Chicago
Chicago, Illinois 60637
(312) 753-3931

PURPOSE:

This professions-wide project (known as the Project on Teaching and Learning in Graduate Geography) has been organized to foster an alternative philosophy of education among doctoral programs in geography in the United States. Challenging the generally accepted view that training for disciplinary command is sufficient for such programs, the project sponsors local pilot ventures in which a practice-oriented approach to problems of teaching becomes part of the preparation for the Ph.D. degree.

AUDIENCE:

National: Our targets are all fifty-three doctoral departments of geography in the United States.

INNOVATION:

(1) Extension of educational reform (hitherto restricted to undergraduate and pre-collegiate institutions) to graduate institutions.
(2) Adoption of the following strategy: sponsorship of teaching development programs (TDP's), all in doctoral departments.
(3) Through this strategy, promotion among professors and prospective professors of (a) systematic thinking about teaching, and (b) valuing of students as sources of information, inspiration, and initiative.
(4) Assumption of responsiblility by a national association representing an entire discipline.

EVALUATION:

Evaluation at both national and local levels is based upon the following intended outcomes:

(a) an improved population of teachers at college and graduate levels,
(b) an array of developmentally conceived, self-sustaining programs in the teaching/learning arts for doctoral students,
(c) a communications network linking geographers skilled in preparing others in the teaching/learning arts, and
(d) the development of principled knowledge germane to the preparation of teachers of higher education.

The means of evaluation have been informal, until the current year, and have included the development of interpretive papers by local directors on the effectiveness of their programs. At present, a formal program of education is in operation. This involves a Follow-Up Study of 100 beginning college teachers, some of whom have participated in this project and others who have not. An effort will be made to determine whether TLGG-related and other kinds of activities are critical to the development and performance of new college teachers.

Viewing the project as a national, mutual-support system, the central office has produced a report on the management of such an enterprise, Preparing Others to Profess, in which recommendations, hypotheses and predictions are set forth, with supporting information, for future managers. A second report, The Importance of Teaching in the Appointment and Promotion of Academic Geographers, transmits information on one aspect of the system's environment: the attitudes of departmental chairpersons toward teaching.

MATERIALS:

The project is not primarily materials-oriented. Our products, as reflected in the outcomes specified above, are improved practices and better qualified persons.

PROBLEMS:

We have encountered two related but distinct difficulties:

(1) Gaining department-wide receptivity to the learning model of education that we are advocating (as an alternative to the accustomed content model).
(2) Securing the departmental commitment required for the institutionalization of the training programs we are sponsoring.

February 1977

PROJECT NUMBER: SED 75-17474 AMOUNT AWARDED: $109,400

DATE AWARDED: July 1, 1975 DURATION: 24 months

PROJECT TITLE: PETROLEUM GEOLOGY TECHNICIAN PROGRAM
PROJECT DIRECTOR: John P. Bedford
PROJECT ADDRESS: Schoolcraft College
18600 Haggerty Road
Livonia, Michigan 48152
313-591-6400, Ext. 314

PURPOSE:

Phase I has been completed, during which time industry was consulted, the Advisory Committee was selected, a trial group of students was identified, and a preliminary curriculum was developed by the Advisory Committee. Phase II activities have seen the trial implementation of the first year of the curriculum. Course materials for the second year are being revised. Evaluation of the program and dissemination of produced materials will be completed by June 30, 1977.

INNOVATION:

Summer work experience has been made a part of the curriculum and is a graduation requirement. The curriculum was developed by the Advisory Committee, working with the staff members of the Geology Department. After approval by the Curriculum Instruction Committee of the college, the program is now a part of the college catalogue; a brochure has been printed and distributed to high school counselors and prospective students.

The curriculum and descriptions of the special courses are listed in the appendix.

MATERIALS:

A bibliography on related subjects for the program has been completed. The publications collected to date have been assigned a special room in the library. The purchase of equipment has been delayed until April of 1977. Industry has contributed well cutting samples, logs, handbooks, reference materials, equipment facilities for field trips, and guest speakers for our class.

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ADDITIONAL COMMENTS:

We continue to receive excellent support from industry.

APPENDIX:

Curriculum:

FRESHMAN YEAR

Fall Semester	Sem. Hrs.
DRFG 111 Engineering Drawing	3
ENG 101 English Composition	3
MATH 112 College Algebra II	5
GEOL 125 Energy Resources	3
GEOL 133 Physical Geology	4
	18

Winter Semester	Sem. Hrs.
ENG 102 English Composition	3
SP 103 Fundamentals of Speech	3
CHEM 111 General Chemistry	4
MATH 119 Trigonometry	3
GEOL 126 Application Petroleum Tech.	1
GEOL 134 Historical Geology	4
	18

Spring/Summer Session	Sem. Hrs.
CT 121 Surveying I	5
or	
ARCH 202 Surveying	3
GEOL 219 Internship	2
	5-7

SOPHOMORE YEAR

Fall Semester	Sem. Hrs.
GEOL 221 Drilling & Formation Eval.	4
BUS 115 Prin. Data Processing	3
PHYS 181 General Physics	4
CON 101 Conservation & Nat. Resc.	3
GEOG 235 Economic Geography	3
or	
Social Science Requirements	3
	17

Winter Semester	Sem. Hrs.
GEOL 222 Well Completion & Prod. Meth.	4
POL S 105 Survey American Gov't	3
SP 201 Discussion	3
PHYS 182 General Physics	4
PHIL 247 Logic	4
or	
Humanities Requirement	4
	18

(Engineering, Physics, and Math through Calculus recommended for students contemplating a four-year degree.)

Description of specialized courses in Petroleum Technology:

GEOLOGY 125: Energy Resources (3-0) 3 sem. Hrs. Survey of the development of all forms of energy. Fossil fuels, including oil, natural gas, and coal have provided the greatest amounts of energy since the beginning of the industrial age. Geographic and geologic occurrences of these fuels and alternative forms of energy are discussed.

GEOLOGY 126: Application of Petroleum Technology (1-0) 1 Sem. Hr. A seminar course for the orientation of students in the Petroleum Technology Program. Guest lecturers, local field trips, student oral reports, work applications, preparation for summer related work. Analysis of employment opportunities. Prerequisite: GEOLOGY 125.

GEOLOGY 219: Internship (0-20) 2 Sem. Hrs. This course is a cooperative assignment for petroleum technology students who have completed two full semesters. Employment will be off campus in a technical capacity with a petroleum company or related service company. A minimum of 320 hours of employment is required for credit. Prerequisites: GEOLOGY 126 and 134.

GEOLOGY 221: Drilling & Formation Evaluation (4-2) 4 Sem. Hrs. The basic principles of drilling practices and equipment. Followed by the techniques of mud logging, drill stem tests, well logging, and other methods of formation testing. Field trips to drilling sites, laboratories. Prerequisites: GEOLOGY 125 and 134.

GEOLOGY 222: Well completion & Production Methods (4-2) 4 Sem. Hrs. The basic types of completion methods are discussed. Subjects cover open holes, liners, screens, perforated casings, and cementing. The aspects of oil production: natural flow, pumping methods, gas lifts, and corrosion problems. Field trips. Prerequisite: GEOLOGY 221.

February, 1977

Geology, Mineralogy
Optical Crystallography

PROJECT NUMBER: SED76-06732 AMOUNT AWARDED: $16,200

DATE AWARDED: May 15, 1976 DURATION: 18 months

PROJECT TITLE: AN OPTICAL MINERALOGY INSTRUCTIONAL PACKAGE ON VIDEO TAPE CASSETTES

PROJECT DIRECTOR: Richard W. Birnie

PROJECT ADDRESS: Department of Earth Sciences
Dartmouth College
Hanover, N.H. 03755

PURPOSE:

The purpose of this project is to prepare a set of video tapes to aid in the study of optical mineralogy. There are several text books available today that present the theory of optical mineralogy. However, much of the use of the theory requires the recognition and interpretation of colors and moving images in the field of view of the petrographic microscope. Single photographs in text books do not adequately describe the optical images or their motion. For a student to approach the subject as a self taught unit, color moving pictures coupled with an audio description are essential to a proper mastery of the subject.

AUDIENCE:

The video tape cassettes are intended for anyone studying optical mineralogy for the first time or undertaking a comprehensive review of previously studied material. Upper level undergraduate geology students and lower level geology graduate students will make up most of the audience. A background of introductory mineralogy and simultaneous reading of an optical mineralogy text will be assumed.

INNOVATION:

This will be the first video tape cassette package for use in teaching optical mineralogy. A demphasis of the formal presentation of optical mineralogy has been a recent trend at many educational institutions. These video tapes will provide a student with the means to pick up much of this important material in a self taught mode.

EVALUATION:

During the preparation of the tapes, students in both introductory optical mineralogy courses and advanced stages of graduate research will be asked to evaluate the films and suggest improvements. Students at three institutions, Dartmouth, the University of Massachusetts, and Massachusetts Institute of Technology, should provide an ample reservoir of student input. In addition, interested faculty members at the three institutions will be asked for constructive criticism.

MATERIALS:

The video tapes will be separated into six units, one dealing with the optical properties of isotropic minerals, two dealing with uniaxial minerals, and three dealing with biaxial minerals. The optical properties shown will include the movement of the Becke Line, the position of the shadow in the oblique illumination test, the different shades of color fringes, the changes induced by use of an accessory plate, uniaxial interference figures, biaxial interference figures, and the effects of dispersion. The finished product will be six video tape cassettes of 3/4" format with each lasting approximately 30 minutes. How the video tapes will be made available has not been decided.

PROBLEMS:

Problems have developed in the technique of photomicrography. The normal 15 watt light source in most microscopes does not provide sufficient illumination for cinephotomicrography of interference figures. A 100 watt light source will be tried to correct this problem.

February 1977

PROJECT NUMBER: SED74-21031

PROJECT TITLE: PROJECT C-BE

PROJECT DIRECTOR: John J. Allan and J. J. Lagowski

PROJECT ADDRESS: The University of Texas at Austin
Chemistry Building 218W
Austin, Texas 78712
(512) 471-3288

PROJECT C-BE was a four-year project with a $1.63 million NSF budget and with about an equal contribution from the University of Texas at Austin. The research phase of the Project ran from September 1971 to September 1975, and reporting and dissemination continued to September 1976. The goal was to study the impact of computer-based instruction at a typical large university.

Under the co-direction of Dr. John J. Allan, Associate Professor of Mechanical Engineering and of Computer Sciences, and Dr. J. J. Lagowski, Professor of Chemistry and of Education, the Project was the first coordinated, massive assault using computer-based techniques ever attempted at one university. Professors in many fields, including engineering, chemistry, psychology, mathematics, physics, zoology, economics, home economics, architecture, and biology participated in the experiment. In addition to the approximately three dozen professors, 55 graduate assistants and 3,300 undergraduate students in the five colleges participated.

Today, the typical professor is being swamped by ever-increasing numbers of students, and yet the students are very much in need of individualized instruction. With the use of the computer as a supplement to course material, we found that teachers can give the students much more individualized instruction, because they have more time to actually interact with the students. Computer-based instructional techniques assist the instructor in teaching to large classes material which is more and more sophisticated. Computer power was developed to provide interactive terminals, interactive graphics, laboratory data acquisition and process control, mark-sense grading, real-time video projection, and terminal-controlled movies and slides.

In order to discover and document the processes that would make the above changes a reality, PROJECT C-BE accomplished four goals. First, the Project identified common concepts that apply to many areas of computer-based education. Second, methods were developed for evaluating the economic and teaching effectiveness of using the computer as a comprehensive aid to higher education. Third, guidelines were developed for administrators who may initiate computer-based techniques in their institutions, considering the pedagogical and financial investments that their schools would have to make. And fourth, PROJECT C-BE has delineated what must be present before computer-based materials can be transferred easily from one institution to another.

All of the publications of PROJECT C-BE have been entered in the ERIC Clearinghouse, and copies may be obtained from there directly. Although PROJECT C-BE was not constituted for the purpose of developing new materials, many useful and transferable materials have been developed. The information number is (512) 471-3288.

February 1977

Biological Sciences
Computer Science
Education

PROJECT NUMBER: SED 74-19057 AMOUNT AWARDED: $105,700

DATE AWARDED: June 6, 1974 DURATION: 24 months

PROJECT TITLE: DEVELOPMENT OF A COURSE OF STUDY IN QUANTITATIVE METHODS FOR NATURAL SCIENCE STUDENTS JUST USING THE BASIC LANGUAGE

PROJECT DIRECTOR: R. P. Banaugh

PROJECT ADDRESS: Department of Computer Science
University of Montana
Missoula, Montana 59812
Phone No. (406) 243-2883

PURPOSE:

It is becoming increasingly evident that a knowledge of, and an ability to use, quantitative methods is necessary for all students of the life sciences. The principal impediment that students of the life sciences experience in attempting to obtain a knowledge and appreciation of quantitative methods of analysis is the well known difficulty such students have with the language of mathematics. Despite vigorous and extensive pedagogical efforts, this difficulty is all too real and longstanding. Consequently, it seemed natural to consider the use of another language which is much more readily understood by nearly all students. This is the language of BASIC, the interactive time-share programming language.

The objective of this project was the development of a course of study emphasizing the formulation and solution of problems originating in the natural sciences just using the higher level programming language BASIC. The goal of the course was the training of students to formulate hypotheses, translate them into an operational computer program and to then analyze the results. Thus, the emphasis was upon the proper formulation of problems and the analysis of results.

A course of study was developed whose purpose was to teach quantitative methods of analysis deliberately minimizing the use of mathematics and emphasizing the use of the BASIC language. This was accomplished by formulating the theory and the problems directly in terms of the BASIC language thus bypassing the language of mathematics. The course has been taught for five years with increasing enrollment each successive year. Since the course is not required, the increasing enrollment in succeeding years attests to the acceptance of the course by the students. Many topics were discussed which could only be handled by a computer even if advanced or sophisticated mathematics was used to formulate the problem. Thus, many significant problems and techniques were described.

AUDIENCE:

The course of study was designed for a first course in quantitative methods for natural science students. It was assumed that the students had at least two years of secondary school mathematics and were familiar with a higher level programming language, preferably BASIC. Actually, the students were required to understand only the four arithmetic operations of addition, subtraction, multiplication and division and the notion of proportion. An introductory college level course in general biology or general ecology would also be helpful since the work was designed for the lower division student in the natural sciences. Interested seniors in secondary schools, as well as natural science students enrolled in junior and community colleges, could easily comprehend the material. The ability of the students to access a computer from a terminal in the time-share mode greatly enhances the course material.

INNOVATION:

The direct formulation, in a programming language, of quantitative hypotheses without the use of mathematics as a middle language was the principle innovation. The development of computational procedures and techniques for problems formulated in this manner was a second innovation. Since the computer readily produces numerical results, another innovation was the ability to devote considerable emphasis to discussing the results and their relation to empirical data. This was in contrast to a mathematically-based course in quantitative methods. In such courses, the principle aim was the teaching of mathematical techniques together with their proper mathematical justification. Thus, it was usually the case in such courses that very little emphasis was placed upon the analysis of the biological significance of the mathematical results nor on a comparison of such results with empirical data.

The course emphasizes the acquiring, by the student, of an ability to properly formulate quantitative hypotheses and to analyze the results obtained from their hypotheses. Thus, the students were forced "to think as a biologist or an ecologist" and were not forced into learning special tricks of solving particular equations, which equations usually represented a greatly simplified version of the biological phenomena in order that the equations be solved.

EVALUATION:

The evaluation consisted of written reactions made by those who had received copies of the work, the reactions of instructors who may have used the material in a course, and the reactions of those who had heard the director present the material. Other evaluations were made by students and instructors at the University of Montana who had queried students of the course.

The author has received over 110 written requests for the work together with 50 oral requests. All requests have been honored by sending the requestors a completed copy of the course work. The author has been asked by several universities to present the work and has done so. Despite the fact that the project is complete, the author is still receiving requests for the work and to present the work.

MATERIALS:

A course of study of approximately 600 pages was developed. The course of study consists of subject matter presented as a series of examples, each of which builds upon the former example. In this way the student gains confidence and his intuition is strengthened as he proceeds. Problems for assignment are given at the end of the chapter. Some of the topics considered in the course were population dynamics, parameter determination or curve fitting, probability, compartmental methods, and life tables. The materials are available at cost from the project director and are being considered by a publisher.

PROBLEMS:

The principle difficulty in the work was one of obtaining realistic evaluations from interested faculty at other institutions. A second difficulty was the obtaining of agreement among natural scientists as to what quantitative techniques should be taught in such a beginning course. There was also some disagreement in the depth of discussion of a particular topic.

ADDITIONAL COMMENTS:

The course of study emphasizes the development of computer programs based upon the students derived hypotheses concerning the problem. It is not the purpose of the course to teach students how to use canned programs or simulation programs. The students must develop their own programs. In this way, the students learn about the limitations of computer based models and also acquire a proper skeptical attitude about large all inclusive programs. The role of experiment is also emphasized and the student is continually reminded that a knowledge of experimental techniques, as well as theory, is necessary for the successful development of a computer based model.

February 1977

PROJECT NUMBER: SED75-02993 **AMOUNT AWARDED:** $90,000

DATE AWARDED: April 15, 1975 **DURATION:** 36 months

PROJECT TITLE: DEVELOPMENT OF MODULAR COURSES IN SCIENCE, TECHNOLOGY, AND SOCIETY FOR FRESHMEN AND SOPHOMORES

PROJECT CO-DIRECTORS: Philip M. Becker and Robert J. Heinsohn

PROJECT ADDRESS: The Pennsylvania State University
University Park, PA 16802
Phone No.: (814) 865-2792

PURPOSE:

The purpose of this project is to provide 1-credit modular courses in science, technology, and society to academic institutions wishing to offer courses in this area but having been unable to do so because they lack the necessary faculty expertise or materials. The modular courses are designed to be used individually or can be organized into various sequential or concurrent groupings.

INNOVATION:

The project will allow for the training of faculty in the area of Science, Technology, and Society, at educational institutions which do not have the facilities or resources to develop such curricula. The 1-credit modular courses will provide maximum flexibility for curriculum design, since the modules will be closely coordinated in their design, so as to optimize the possibilities for sequential or concurrent groupings.

EVALUATION:

The initial selection of modules was considered by a panel of 4 advisors from outside the Penn State University system, including Douglas Feaver (Lehigh University), Ezra Heitowit (Cornell University), John Truxal (SUNY, Stony Brook), and George Berg (University of Rochester). During Spring, Summer, and Fall Terms, 1977, the modules will be tested in classroom situations at the Commonwealth Campuses of Penn State, and the modules will be reviewed by the advisory panel, augmented by a member of the lay public (James McClure of State College, PA). A questionnaire has been developed for the evaluation process, and the results of the evaluations will be used by the module authors to modify the modules to their final form.

MATERIALS:

6 modules are being create The topics are:

1. Food for the World
2. Technological Forecasting
3. Science, Philosophy, and Religion

4. Materials and Energy Resources
5. Technology
6. Technological Change and Human Values

The modules will include course outlines, study guides, bibliographies, and related audi-visual materials as appropriate. The materials will be available for distribution after plans for dissemination have been approved by NSF.

PROBLEMS:

We have found that we had to prepare much more narative writing for the modules than we anticipated, and thus the cost in time and money was greater than we budgeted for. Therefore we are somewhat behind schedule.

ADDITIONAL COMMENTS:

None.

February, 1977

Physics, Mathematics

PROJECT NUMBER: SED 74-2089-A02 AMOUNT AWARDED: $660,933

DATE AWARDED: 6/1/74 - 5/31/77 DURATION: 36 months

PROJECT TITLE: COMPUTER GRAPHICS IN LEARNING

PROJECT DIRECTOR: Alfred Bork
Co-directors: Richard Ballard
Joseph Marasco

PROJECT ADDRESS: Physics Computer Development Project
University of California
Irvine, California 92717
Phone: 714-833-6911

PURPOSE:

The project explores the use of interactive computer graphics as an aid in learning. The three phases concern 1) the restructuring of a beginning physics course to allow student choice of content as well as pacing; 2) development of more effective ways of employing computers in education, including improved authoring systems; and 3) dissemination of programs and information about the best utilization of the computer in learning environments.

AUDIENCE:

The project develops material aimed primarily at beginning courses in science and mathematics. A major effort has been devoted to beginning physics, but materials employing the underlying software have been developed in mathematics, chemistry, ecology, and medical education. Certain computer dialogs, although developed with undergraduates in mind, have also proved to be valuable in physics courses at the Junior and Senior level.

INNOVATION:

The project seeks to develop compelling examples of effective use of the computer in learning, particularly with regard to graphical facilities, hoping to provide new and exciting individualized learning resources for students which can be employed in both a standard and a PSI environment

An important aspect of our work is to develop an authoring system which allows faculty with no direct knowledge of computer programming to prepare student-computer dialogs. The chances of success, particularly from the long-range point of view, are considerable.

EVALUATION:

The NOMOS institute has contracted with us for evaluative efforts during the last two years of the project. The principal evaluator is Michael Scriven from the University of California, Berkeley. A copy of the evaluation plan is available from the Project Director, as are specific components of the evaluation. Much of the evaluation is formative, and is employed to improve the quality of the materials. Feedback from the computer itself is a valuable source of data for this evaluation effort.

MATERIALS:

The major products of the Project are the student-computer dialogs, the authoring system including software, the course management system, auxiliary (non-computer) class materials, and papers documenting and describing the work of the group.

About 75 dialogs have been developed directly in the project, and others have been generated through the use of our software and authoring system. A few representative ones, with a brief description, are the following:

CIRCUIT - DC circuits; written by several students
FIELD - Electrostatics, including learning sequences, quizzes, and field plotting capability
LUNA - Phases of the Moon as a scientific model
MAXWELL - Maxwell's equations and plane waves
MFIELD - A phenomenological approach to magnetic fields
MOTION - A controllable "F = ma" world for student exploration
SLOPE - An online mechanics quiz, with extensive help sequences
VECTORS - An online quiz on vector analysis.

The dialogs are available on magnetic tape from the project; they run on Sigma and 560 computers employing the CP/V operating system, and conversions are underway for several other computers.

The Dialog authoring software (macros and Fortran) is also machine dependent; it exists now on several computers. The authoring process is described in several available documents, and members of the Project have run, and are willing to run, workshops on the authoring process. Of particular note is an APL-based workspace to aid with the graphic design aspects of dialog preparation; the faculty member or student programmer places pictures and text on the screen and moves them until the desired arrangement is completed, and then the computer writes the macro-based code to produce the display so created.

The course management system developed in several iterations does the record keeping in the multitrack, restructured course, and allows both the student and the teacher to gain information about progress in the course. The instructor can determine quickly which students are having difficulty, and can monitor the performance of the online quizzes, with convenient graphical displays. Students can gain information about their own progress in the course. As the course management system is newly developed, it is not yet in a form that can be sent to others.

Several slide-tape shows, partially supported by this project, are in use. Class notes are also available at cost; although they are not strictly a product of this Project, they relate closely to the computer-based material.

A list of reprints and preprints, currently listing 59 available items describing many aspects of the work of the Project, is available from the Principal Investigator.

PROBLEMS:

Perhaps the major problem arose when the multitrack course was given for the first time to a beginning physics class of 300 students. The unit tests were administered, in the usual PSI fashion, by tutors. Given the departmental resources available, we were very much overloaded; often it was impossible to provide immediate feedback to the students. Because of this we moved all the unit tests to the computer during the summer of 1976. The interactive testing situation allowed us to both test more effectively, and provide a higher level of individualized help to students.

We are often frustrated at the gap between what we have done, and what we would have liked to do. We believe that we, and others, still have much to learn about the use of this new medium in education. In spite of this, we are also happy with the progress we have made.

February, 1977

PROJECT NUMBER: SED74-20180 **AMOUNT AWARDED:** $96,370

DATE AWARDED: June 1, 1974 **DURATION:** 24 Months

PROJECT TITLE: CURRICULUM INNOVATION IN THE AREA OF SCIENCE, TECHNOLOGY, AND SOCIETY

PROJECT DIRECTOR: Raymond Bowers

PROJECT ADDRESS: Program in Science, Technology, and Society
Clark Hall
Cornell University
Ithaca, New York 14853
(607)256-3810

PURPOSE:

The purpose of this project is to conduct a comprehensive study of the current state of academic activities in the general area of science, technology, and society (STS). The study includes: i) a nationwide assessment of instructional efforts, both on a course level and on a program level; ii) a determination of the need for curriculum materials, and iii) the development of themes and concepts for organizing curricula in STS studies. The study provides the information, now lacking, for determining the curriculum materials (subjects, types, and levels) which currently need to be developed and disseminated.

AUDIENCE:

The results of the study will be of special interest and value to: i) faculty, for whom it will identify instructional resources; ii) college and university administrators, who will find descriptions of current institutional approaches for establishing formal teaching/research programs; iii) funding agencies that are seeking to expand their support in this field; and iv) an increasing number of students interested in STS studies, who will be provided with a broader base of information.

INNOVATION:

A nationwide survey of all two- and four-year colleges and universities has been completed. The survey questionnaire requested information concerning special programs, courses, colloquia, research, curriculum materials available, and curriculum materials desired. Relevant information has been received from nearly 400 institutions in the United States.

Analysis of the survey data has produced: i) profiles of courses according to principal subject area, departmental and program sponsorship, type of audience and mode of instruction;

ii) an identification of those clusters of programs and courses that constitute significant subfields in STS studies; and iii) predictions of future trends in the STS field.

Special attention has been given to an investigation of the institutional characteristics (both administrative and philosophical) of different STS programs. Site visits to several universities have provided detailed information on program development.

EVALUATION:

The study has a national advisory committee that has aided the project director and his associates in i) interpreting the data from the national survey; ii) contributing to the definition of an STS studies curriculum; iii) predicting future trends; and iv) defining the scope of the study. The committee has reviewed drafts of components of the study report. The five members of the committee are active in the STS field as teachers, researchers, and curriculum planners.

MATERIALS:

The study has resulted in the publication by the Cornell STS Program of a comprehensive Guide to the Field of Science, Technology, and Society, listing courses, programs, research activities, curriculum materials, and general resources. The course and program data is being coded for machine computation; a computerized data bank will be made available to interested parties.

Science, Technology, and Society: Guide to the Field, Directory of Teaching, Research and Resources in the U.S. E. D. Heitowit, J. Epstein, G. Steinberg (eds) is available from the National Technical Information Service; NTIS Accession No. PB262 487/AS for $13.50 (Hard Copy) and from the ERIC Document Reproduction Service.

A final project report provides an analysis of data contained in the directory, results from program site visits, a summary of recent conferences and workshops, and an overall assessment of needs for further development of the STS area.

PROBLEMS:

Complete information from all institutions (especially the smaller ones) in the United States has not been obtained. Survey work was hampered by the lack of a common definition of science, technology, and society studies, particularly where the boundaries of the field are concerned. The present data are, however, representative of current academic activities in this area.

ADDITIONAL COMMENTS:

There is now widespread activity in interdisciplinary teaching and research on the interaction of science and technology with society. The development of this field, although incomplete, is moving rapidly. The present study provides the necessary assessment of the STS field to forecast its future directions. Comparisons are made with the emergence and development of other interdisciplinary fields. A key distinction is that STS studies are diverse, ranging in educational objectives from liberal studies to professional training, and ranging in focus from public policy to humanistic aspects.

February 1977

Interdisciplinary
(Science for Secondary Schools)

PROJECT NUMBER: SED 72 - 06306 **AMOUNT AWARDED:** $4.129.544 (to date)

DATE AWARDED: 9/29/1972 Beginning grant **DURATION:** Funded to 9/30/1977 anticipate continued funding

PROJECT TITLE: INDIVIDUALIZED SCIENCE INSTRUCTIONAL SYSTEM

PROJECT DIRECTOR: Ernest Burkman

PROJECT ADDRESS: Florida State University, Tallahassee, FL 32306
[Project headquarters: 415 N. Monroe Street
Tallahassee, FL 32301; Telephone: (904) 644-2864]

PURPOSE:

The Individualized Science Instructional System (ISIS) is developing a flexible, open-ended, interdisciplinary curriculum that will facilitate individualization of science instruction at the high school level.

AUDIENCE:

Aimed primarily at non-science oriented high school students, the content is presented in the form of individualized printed modules, or "minicourses," each one dealing with an aspect of physics, chemistry, life science, earth science, or multidisciplinary topics. Over 60 minicourses are being developed. Each requires about three weeks of classroom work. Teachers and schools can use them to design discipline-oriented courses, to produce courses with greater content diversity, or to supplement existing courses. Tied to real-world situations and the things students want as well as need to know, the minicourses are suitable for use in inner-city as well as suburban schools.

INNOVATION:

ISIS believes that a basic understanding of science should be part of the well-rounded education received by all high school graduates. Thus, an attempt should be made to provide science courses that appeal to students who may or may not be continuing on to college and probably won't major in science if they do. Maximum flexibility is provided so that teachers and school systems can develop individualized courses appropriate for local needs. In addition to supplying a wealth of materials for average and below average students, selected materials are included to challenge the more advanced or highly motivated students. All minicourses are objectives based and the materials have a high picture-to-text ratio.

EVALUATION:

Approximately 200 teachers and 25,000 students in nearly 100 high schools across the nation have thus far participated in the rigorous formative evaluation of ISIS minicourses. Briefly, their input takes six forms.

1. Comments written by teachers directly on the pages of minicourse materials.
2. Written responses by teachers to about 6 to 10 different questions about critical or unique aspects of each minicourse.
3. Tape recorded discussions of minicourses by groups of teachers who have tried them in their classrooms.
4. Samples of booklets and notebooks used by students to record their responses to questions and the results of their investigations.
5. Responses by students to a multiple choice format minicourse questionnaire that aids in pinpointing troublesome areas.
6. Comprehensive data showing how well students succeed, item by item, on ISIS minicourse tests. This allows revisors to identify those instructional activities that are failing to help students achieve the minicourse's stated objectives.

In addition, feedback from content reviewers and members of a citizens review committee help bring to light content errors and matters related to bias and sensitivity. The end result of the extensive feedback and evaluation process is a better end product.

MATERIALS:

When completed, the entire set of minicourses will consist of 15 physics minicourses, 14 chemistry, 22 biology, and 11 of various types, including psychology, geology, astronomy, and meteorology. These can be assembled to provide disciplinary and interdisciplinary courses as desired. For each minicourse there will be an annotated edition for teachers, two forms of a test for students, and various ancillary materials.

In an effort to keep down the equipment costs for schools adopting ISIS, the laboratory work makes use of materials and apparatus normally available in high school science labs.

Nevertheless, each minicourse has a few ancillary items peculiar to it, such as audio tapes, posters, and games. And there are requirements for chemicals, minerals, and other consumables, many of which can be obtained locally.

By 1980, all ISIS books, including student and teacher management publications should be widely available on the commercial market. For information on ordering and availability of ISIS minicourse materials, contact the nearest Ginn Representative or write to the publisher:

ISIS Information
Ginn and Company
191 Spring Street
Lexington, MA 02173

PROBLEMS:

Many teachers still aren't trained to teach in an individualized setting. Others need assistance in adapting flexible curricula materials so they best meet local needs. ISIS, like other innovative programs, would benefit from a nationally supported teacher training program.

Another problem is that science courses at the upper high school level are not designed for and frequently ignore the ISIS target population. Junior and senior courses typically serve the college-bound with strong emphasis on the science major.

February 1977

Physics, chemistry, biology,
geology and environmental
sciences

PROJECT NUMBER: SED 74-20286 AMOUNT AWARDED: $70,900

DATE AWARDED: September, 1973 DURATION: 30 months

PROJECT TITLE: "THE DEVELOPMENT OF NUCLEAR EXPERIMENTS AND SENIOR RESEARCH PROJECTS FOR UNDERGRADUATES"

PROJECT DIRECTOR: Dr. Jerome L. Duggan

PROJECT ADDRESS: Department of Physics, North Texas State University,
Denton, Texas 76203. Phone No.: (817)788-2626

PURPOSE:

In this project a series of nuclear science modules are being developed. The modules are being developed for the following academic disciplines: physics, chemistry, biology, geology and environmental sciences. In each area the modules are rather self contained and center around some piece of experimental nuclear instrumentation.

AUDIENCE:

The modules are intended for undergraduates at the junior or senior levels in the above disciplines. A background in freshmen physics, chemistry or biology is assumed. In most cases these modules will be used in conjunction with a course in nuclear science, associated with the given discipline. In particular, they serve as the laboratory portion of the course. It is also possible to use the module as a stand along project for the student. Adequate reference material is supplied with each module so that the student can develop the necessary background to complete the module. Pretesting and post-testing questions are provided with each module. In many cases, computer programs are supplied which are quite helpful in reducing the atomic and nuclear data that is taken in the experiment. Some of the advanced modules are quite appropriate for senior projects which are intended to be done at a rather high level of sophistication.

INNOVATION:

As was mentioned above, each of these modules is designed around some "state of the art" piece of nuclear instrumentation. We have, for the most part, designed experiments for nuclear appartus that is not normally found in undergraduate experimental programs. This equipment, in general, does not represent a large financial investment on the part of the university. The innovation therefore, is in familiarizing students and faculty in the use of certain atomic and nuclear devices that are not normally found in undergraduate laboratories.

February, 1977

EVALUATION:

Before the modules are put in their final form and printed, they are sent out to a number of pilot universities in which they are used in the undergraduate program at least for the course for which that module is intended. The professor at that university then has a good opportunity to criticize and suggest possible changes in the module. These changes are then included into the final printed form of the module. Through this project we hope to become a center for nuclear modules that are written by various professors throughout the United States. So far materials from over 100 universities have been sent in to our center. This material is screened and sent back to the university professor with possible format changes and suggestions from the evaluation panel. The module is then printed and then sent out to the pilot schools mentioned above. By this technique we hope to make these modules available to the entire nuclear science community.

MATERIALS:

When completed, the project will have produced manuals of modules in the following disciplines: physics, chemistry, biology, geology and environmental sciences. Each manual will contain approximately 12 modules in that area. In addition to the above, a published book of abstracts will also be provided periodically in each of the above disciplines. These abstracts will summarize modules that are produced by the project and made available by the authors.

PROBLEMS:

The major problems associated with this project have been in the evaluation procedure. It has taken a rather long amount of time to get material back from the pilot schools (approximately 50 pilot schools have been involved in this project). However, in general, the cooperation has been very good from these universities.

ADDITIONAL COMMENTS:

By using such a large number of authors, we have given quite a bit of scope to the project. Many of these experimental modules were being used in universities. The problem was that University A was not aware of the fact that University B had this material. We have provided a mechanism so that all universities should be able to find out what nuclear modules are being used at other schools.

Any university professor that wishes to participate within this project, either as a contributor or an evaluator is welcome to get in contact with the project director. A larger participation in both of these areas will assure a successful and continuing project.

PROJECT NUMBER: SED-73-07321-A05

DATE AWARDED: April 15, 1973

AMOUNT AWARDED: $523,770.00

DURATION: 42 months

PROJECT TITLE: A COMPUTER BASED HIGH SCHOOL MATHEMATICS LABORATORY (SOLOWORKS)

PROJECT DIRECTOR: Thomas A. Dwyer

PROJECT ADDRESS:
University of Pittsburgh
Pittsburgh, PA 15260
(412) 624-6461

PURPOSE:

Soloworks developed a basically new approach to using technology in support of human learning. The emphasis was on the use of computers to provide flexible, highly interactive experiential/creative worlds for learners of high school age.

The basic principles guiding the work of the project were (1) that instruction is a necessary, but not sufficient condition for significant learning, and (2) that the most promising new developments in education will be those that manage to make the student a superior "receiver" of instruction. The concrete approach taken by the project in applying this second principle was to organize labs where students could develop their powers of "instructional receptivity" by working inventively with ideas from mathematics, science, and computer science. The work they did involved designing, debugging, and eventually creating new and fairly complex systems.

To support this work, Soloworks designed laboratory artifacts and systems that could be controlled by computer algorithms, using concepts that centered around the unifying ideas of computing, dynamics, synthesis, and modelling/simulation. These concepts were then expanded to define prototype curricula intended as a source of extensible ideas for educators interested in developing new kinds of computer-based programs for their schools.

AUDIENCE:

Project Soloworks was aimed primarily at secondary school mathematics, science, and computer science programs. Its direct audience (through correspondence, articles, newsletters, films, visits, talks, and workshops) was secondary teachers, their students, other researchers, teachers in training, and teachers in schools of education. The project mailing list averaged approximately 1000 names. The Soloworks laboratories were kept sufficiently flexible to be useful in other educational or community settings, e.g., museums, libraries, youth clubs, or community centers. A number of ideas from the project influenced the software and hardware of computer manufacturers. In a few cases, secondary schools which sponsored adult education programs used Soloworks ideas, consulting, and materials to help design their programs.

INNOVATION:

The project pioneered the concept of "solo-mode" computing. The word "solo" describes a pedagogy based on the intense involvement and accomplishment that occurs when something is a personal quest. The goal was to involve the students as "mathematicians" and "scientists", not in the professional sense, but in the sense of people who work with and invent generalized systems. Minicomputers and microcomputers were used to control devices which allowed for a wide range of student interests, backgrounds and talents. Examples included several computer graphics systems, a versatile music system, the dynamic control of game-like simulations (switch-controlled, special-device-controlled, or controlled through a flight simulator), robots, electronic audio components and measuring instruments, and multiterminal configurations for group explorations.

The pedagogical ideas behind the laboratories recognized that human learning takes place in three broad categories or modes: (1) transmittal-receptive, (2) experiential, (3) creative. These modes were viewed as complementary. In particular, it was found that activities in categories (2) and (3) helped students become excellent receivers of advanced ideas transmitted by instruction. The curriculum design principle which underlay the writing of modules held that there are important advantages to starting with major, interesting ideas, adding detail on the basis of a "backtracking" approach, rather than a linear sequential scheme.

EVALUATION:

Critera for evaluation and methods of evaluation were guided by the following objectives: (1) to bring students to an increased ability (and willingness) to set problems for themselves; (2) to develop care in students about the outcomes of their work (the craftsmanlike attitude); (3) to foster increased critical thought about existing models and techniques; (4) to clarify the relevant mathematical, scientific and computer science facts, concepts, and skills (some classic, some very new); (5) to bring students into contact with ideas that cannot be expressed or explained in a transmittal-only learning environment.

The evaluation process was formative, involving trials with small groups of students, and criticism by a variety of teachers and other professionals (both technical and educational) who used our facilities, or with whom we corresponded. This resulted in a number of changes to our ideas and hardware which occurred progressively throughout the history of the project. The most recent result has been a start on adapting our work to the new, low-cost microcomputers.

The extent to which we succeeded in meeting the objectives given above was judged in terms of the competencies exhibited in individual student work. Student files accumulated over the project's span show substantial achievement in all areas as judged by teachers as well as project staff.

MATERIALS:

Topics and ideas were shared through prototype curriculum modules, Project Soloworks Newsletters, and many journal articles. A total of about 20,000 newsletters, reprints, and samples of modules were distributed by the project. Continued availability of materials is through ERIC. A number of modules and articles were reprinted in Creative Computing and BYTE (estimated total readership is over 100,000). Articles were published in journals such as Int'l. Journal of Man-Machine Studies, ACM's SIGCUE Bulletin, AEDS Journal, School Science and Mathematics, Technological Horizons in Education, The Int'l. World of Computer Education, EDUCOM Bulletin and others. A film, "Soloworks #1", suitable for use at workshops and meetings was produced (widespread distribution is not funded at this time). An additional twenty-five reports were produced by project staff as part of a project "working paper" series.

PROBLEMS:

There is a tendency for the transmittal-receptive mode to predominate if experiential and creative activities are not carefully planned and strenuously maintained. This is in part a historical, cultural phenomenon. A partial solution outlined (but not implemented) by the project is a new kind of teacher education, parallel in many ways to the student experiences implied by the Soloworks laboratories. This would be based on similar pedagogical and curriculum principles, but with greater emphasis on management of the creative mode.

Equipment used was, as far as possible, that which was widely available. However in some cases our ideas were too innovative, and we had to build hardware or design special software to create the environments we had in mind. An unforeseen solution to this problem appears to be the advent of low-cost microcomputers with advanced peripheral devices and interfaces. The final activity at Soloworks therefore concentrated on adapting solo ideas to this new technology. Because the microcomputer movement is very new, this work needs to be continued for some time.

Teachers and school administrators interested in implementing a solo-type program need periodic help and support on a more regular basis than we have been able to provide. Involving them in experiential and creative mode learning will be helpful, but a more specific management plan and training in its use is also needed. Some preliminary work shows that developing such a plan is feasible, and of definite interest to schools.

ADDITIONAL COMMENTS:

The basic significance of developing and sharing the solo idea is that it has added new dimensions to the way educators can think about learning and technology. The project has articulated deep ideas that, although sensed by many teachers, were in need of the well-developed expression made possible by a concentrated program. The very favorable assessment of the solo idea expressed by project correspondents reflects an equal interest in imaginative ideas, products that make these ideas concrete, and continued leadership in their use.

February 1977

Discipline(s): All

PROJECT NUMBER: SED 75-17157 AMOUNT AWARDED: $163,500

DATE AWARDED: June 1, 1975 DURATION: 32 months

PROJECT TITLE: INVENTORY OF COMPUTING ACTIVITIES AND RELATED DEGREE PROGRAMS IN U.S. HIGHER EDUCATION

PROJECT DIRECTOR: John W. Hamblen

PROJECT ADDRESS: Computer Science Department
University of Missouri-Rolla
Rolla, MO 65401
(314) 341-4491

PURPOSE:

To collect and prepare for publication extensive data on computers and their uses in the higher education institutions of the United States. Previous inventories were conducted for 1966-67 and 1969-70 and are now out of print. A second volume containing interpretations of the data by approximately ten individuals who have researched various aspects of computing activities in higher education will also be prepared for publication.

AUDIENCE:

The primary audience consists of those who will be supplying the data. Directors of college and university computer centers, chairmen of departments of computer science, their deans and other administrative officers of the nearly 3,000 college and university systems and campuses. Other interested groups are federal agencies, publishers, computer vendors, software vendors, computer societies, etc.

INNOVATION:

The previous inventories led only to the publication of the summaries and the interpretation was left to the readers. This project will also produce an analytical and interpretative report so that the highlights can be absorbed more quickly.

EVALUATION:

The critical element in such a project is the data collection instrument, instructions, editing of returns by persons knowledgeable of higher education computing activities and the correctness of the numerous computer programs required to produce the summaries. The latter two are assured by the experience of the project director with three previous studies and the first two were sent for review by representatives of approximately thirty associations and agencies. The interpretative report will also be, in some sense, of an evaluative nature.

An independent follow-up study was done after the 1969-70 inventory with no significant discrepancies or discoveries. Consequently, no follow-up is planned for this project.

MATERIALS:

Two publications will be prepared by the project. One will be similar to the 1966-67 and 1969-70 books which were published by the National Science Foundation and the other will be an interpretative report prepared by ten or so individuals who have researched some aspect of computing in higher education. Plans for publication and dissemination will be made as the publications approach completion.

PROBLEMS:

The forms and instructions were reviewed, revised and submitted to NSF for OMB clearance in January 1976. There was disagreement as to whether this project as a research effort came under OMB's purview but the forms and instructions were submitted as a renewal request of the 1969-70 instrument. After a series of meetings and correspondence, the OMB rejected the request, as submitted, in January 1977 resulting in a one-year delay. Current plans are to delete the items which would require the most effort in reporting and yet not of the greatest interest to the consumers of the results. If approval can be obtained without undue delay, data will be collected for the 1976-77 academic year.

February 1977

Natural Science,
Health Science,
Social Science,
and Mathematics

PROJECT NUMBER: SED 72-06819 **AMOUNT AWARDED:** $2.2 million since 1968

DATE AWARDED: April 1972

PROJECT TITLE: BIOMEDICAL INTERDISCIPLINARY CURRICULUM PROJECT

PROJECT DIRECTOR: Leonard A. Hughes

PROJECT ADDRESS: 7700 Edgewater Drive, Oakland, CA 94621
Telephone: (415) 635-0290

PURPOSE:

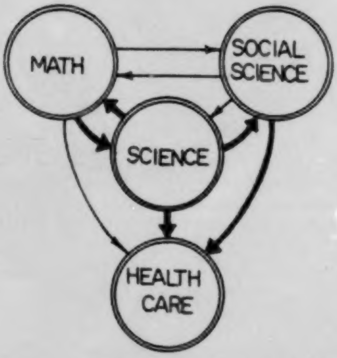
The purpose of the project has been to develop, trial-test and revise a health-career-oriented two-year interdisciplinary science, social science and mathematics curriculum. The curriculum is designed to overcome the problem of low student motivation by relating the content of all three disciplines to health problems and careers that are of interest to students. The curriculum package consists of all special instructional material needed by both students and teachers for approximately 1300 classroom hours.

AUDIENCE:

The curriculum is intended primarily for high school students who are interested in (1) pursuing a career in the health care field, (2) pursuing higher education in any of the natural or social sciences or in mathematics, or (3) obtaining an interdisciplinary high school education that will contribute to the process of developing into a mature person. The curriculum can also serve as a resource for teachers wishing to adapt parts of it into their existing courses. Finally, the curriculum can be adapted to special course offerings to meet the needs of adult education and community colleges.

INNOVATION:

The most innovative aspect of the curriculum is in the design of an integrated interdisciplinary curriculum consisting of biomedical science, social science and mathematics. The biomedical curriculum is illustrated by this model:



The science curriculum provides a reservoir of health content which has been integrated into the mathematics and social science courses. The interdisciplinary contributions flow primarily between science and mathematics and from science to social science on a prevailing current of health problems.

The science curriculum stresses activity-centered learning, which is partly made possible by the use of special but inexpensive instrumentation. It provides hands-on experience that is usually not available at the high school level. The mathematics portion of the curriculum is strongly applied. Recently learned math skills are directly used in the science class. In addition, data developed during science activities are directly used for math applications. The social science course applies processes such as value-clarification and decision-making strategies to many of the topics raised in the science course. Two such topics are genetic counseling and organ transplants. The social science course also makes use of math skills for manipulating data from social-scientific inquiries conducted by students.

EVALUATION:

Complete revision of all project materials was based upon extensive classroom feedback from approximately 140 students and 15 teachers during a two-year trial. In December 1975, two national panels, each consisting of 12 members, reviewed project materials that had been developed to that date. The favorable results of that review, which are available from the National Science Foundation, provided the principal basis for continued project funding.

It is known that a large percentage of Biomedical trial students went on to colleges and universities and were found to be especially competent in laboratory science skills. The first students taught revised materials will not graduate until June 1977, but their progress will be monitored as follow-up resources become available.

MATERIALS:

Science materials available are texts, instructor's manuals and laboratory manuals for:

Unit I	Respiration in Health and Medicine
Unit II	Nutrition in Health and Medicine
Unit III	The Circulatory System in Health and Medicine
Unit IV	The Nervous System in Health and Medicine
Univ V	Genetics and Reproduction in Health and Medicine
Unit VI	Trauma and the Muskuloskeletal System

In addition, a Biomedical Instrumentation Package and breadboard computer are available. One set of hardware is recommended for every three students.

Mathematics materials available are texts and instructor's manuals for:

Unit I	Measurement, Linear Functions and Dimensional Algebra
Unit II	Propagation of Error, Vectors and Linear Programming
Unit III	Quadratics
Unit IV	Symbolic Logic, Trigonometry and Statistics
Unit V	Introduction to Logarithms, the Binomial Theorem and Genetics
Unit VI	Rates of Change
Unit VII	Exponential Functions

Social Science materials available are texts and instructor's manuals for:

Unit I	Health and Society: Basic Social Science Inquiry into Health-Related Problems
Unit II	Health, Culture and Environment*
Unit III	Decision-making and Health in American Society
Unit IV	What Influences Human Behavior?
Unit V	Perception, Learning and Intellectual Growth
Unit VI	Population Growth and Genetic Engineering
Unit VII	Health in the Community: Inquiries and Applications**

* This Unit includes four books of readings -- Africa, Aq Kupruk (Afghanistan), Southeast Asia, and Urbanization -- in addition to the usual Student Text.

** There is no Student Text for this Unit. Students devise research projects using methods taught in earlier Units.

Inquiries should be sent to:

Biomedical Curriculum Project
Care of Health Systems Management Corporation
7700 Edgewater Drive
Oakland, CA 94621

PROBLEMS:

The main problems connected with utilization of the Biomedical Curriculum have been related to student and teacher selection. These have been solved by (1) selecting students with grade-level reading skills and adequate comprehension of first-year algebra and (2) developing a team of three teachers who are committed to achieving the interdisciplinary goals of the curriculum.

The detailed instructor's manuals have minimized the amount of pre-service and in-service teacher training required.

February 1977

Undergraduate Science
(Biology, Physics,
Chemistry, Mathematics,
Social Sciences,
Management Science)

PROJECT NUMBER: SED75-06596 AMOUNT AWARD: $1,091,850

DATE AWARDED: May, 1975 DURATION: 42 months

PROJECT TITLE: CONDUIT: Consortium For The Dissemination Of Computer-based Curriculum Materials

PROJECT DIRECTOR: James W. Johnson

PROJECT ADDRESS: CONDUIT, 100 LCM
The University of Iowa
Iowa City, Iowa 52240
(319)353-3170

PURPOSE:

The purpose of this project is to design, implement, test, demonstrate and evaluate the workings of an organized dissemination system for computer-based curriculum materials for higher education in science. The intent of the dissemination system is to speed the acceptance and stimulate the production of curriculum materials which utilize the new technology of computing. The problem, identified by several commissions, studies and reports, is that materials are locally produced for local use and what dissemination does exist is voluntary, episodic and relies on special agreements between individuals. As a result, a potentially powerful force for enhancing and understanding science is significantly underutilized at an enourmous social cost.

During the project period CONDUIT will seek to be a reliable source of information about computer-based curriculum materials, a producer of standards for design and evaluation of materials for widespread use, and a distributor of certified materials. To accomplish this, several (fourteen to date) regional computer networks have joined together to provide the elements for an effective dissemination system. The elements include subsystems for soliciting, quality controlling, packaging, publicizing, distributing, maintaining and revising materials. Once these subsystems are in place and operational, the model should be reproducible by others seeking to distribute non-traditional materials. In addition, the economic viability of the model will be tested against the hypothesis that such an effort can become substantively self-supporting once problems are solved and a critical mass is reached.

AUDIENCE:

The audience for the CONDUIT project is science curriculum decision makers at all colleges and universities in the United States. The ultimate beneficiaries are undergraduate science students enrolled at the colleges. By the last phase of the project we intend to have over 100 curriculum packages (currently 40) available for distribution to over 1000 colleges (currently over 125). Disciplines covered include Biology, Chemistry, Geography, Economics, Mathematics, Physics, Political Science, Psychology, Management Science and Sociology. Certified materials are tested for use on several differing types of computer systems for use on large machines at large universities and small machines at small colleges. The materials cover key concepts in courses that are taught at a broad range of institutions and that enroll a large number of students. Some materials may be useful at the secondary or graduate level.

INNOVATION:

The distinctive aspect of this project is that it attacks the total problem of dissemination from producer to user for non-traditional, innovative curriculum. In doing this, CONDUIT is experimenting with ways of making computer-based materials developed at one locale transferable to other locales. This experiment has technical and psychological dimensions that require innovative, yet pragmatic techniques for translation, documentation and pedagogical transfer. The advantage of this approach is that developers may have some guidance in producing non-traditional materials for widespread dissemination. On the user side, materials may be adopted locally without a great deal of effort in translation and documentation. Results to date indicate that we can be successful in solving technical problems in transfer and that with the proper approach, and time, psychological barriers can be surmounted.

EVALUATION:

The materials of the project are evaluated by national review panels established in each disciplinary area. In addition, an outside evaluator is surveying all recipients of materials to determine if the materials were easy to implement and worthwhile for use in undergraduate courses. A separate evaluation is attempting to validate the review and testing model by comparing prerelease evaluation with evaluations by actual users of materials. The results of these evaluations will be available in published reports and in the final report.

They will be used internally to revise the review-test-package process. The overall evaluation of the project will be its ability to become self-supporting by effectively meeting an established need.

MATERIALS:

Materials developed will include: periodic newsletters (PIPELINES), informational catalogs, CONDUIT Reviews and Abstracts. Over 100 reviewed and tested curriculum packages will be available in addition to technical reports providing guidelines for transfer of computer-based materials. A commercial publisher may be sought for State of the Art Reports, describing the status of computing use in ten undergraduate disciplines. All other reports, publications and newsletters are available from the project director.

PROBLEMS:

With the exception of natural disaster (a fire destroyed our quarters), the project is on target. A problem we did anticipate, solicitation of materials for distribution, has not occurred. On the other hand, the conversion of existing computer-based curriculum materials into a transferable form has required a greater effort than expected. In addition, we've had to experiment with new forms of physical transfer because several mini-computer systems do not read standard media. We are automating the translation process as much as possible and developing new transfer media such as; telecommunications, tape cassettes, and floppy disks, to overcome our problems. A problem in evaluation has been the long lead times in curriculum decisions.

February 1977

Interdiciplinary

PROJECT NUMBER: SED 75 - 18976 AMOUNT REWARDED: $54,500

DATE AWARDED: May 15, 1975 DURATION: 24 months

PROJECT TITLE: DEVELOPMENT OF A CLOSE RANGE PHOTOGRAMMETRY TECHNICAL PROGRAM

PROJECT DIRECTOR: Dr. Joel Kobelin

PROJECT ADDRESS: Miami-Dade Community College, North Campus
11380 N. W. 27th Avenue
Miami, Florida 33167
Phone: (305) 685-4202

PURPOSE:

The long range goal of the project is development of a model two year program leading to an associate degree for training photogrammetry technicians to (1) work in museum or archives settings, or (2) transfer into bachelor's degree programs for continuing their education.

Specific objectives of the project include (1) expanding the application of photogrammetry skills in museum and archives use, and (2) developing implementation for other institutions.

AUDIENCE:

This program is being explored primarily for the community college student who has interest in scientific and technical areas but who has also an appreciation for historic and aesthetic fields. Other groups for whom this project has relevance include (1) museum personnel, (2) photogrammetry personnel, (3) state departments, upper division universities, and others concerned with new applications of existing technology.

INNOVATION:

There is presently no curriculum in the United States focusing on the application of close range photogrammetry in museum and historic preservation and restoration activities. Further, the interdisciplinary aspects of combining the scientific and technical with the social sciences and humanities areas suggests new relationships among curricula and the faculty teaching them.

Finally, the concept of minimizing additional proliferation of courses, through new combinations of existing courses to develop a new program suggests an economically realistic approach.

EVALUATION:

An interdisciplinary national advisory committee including representation from the photogrammetry, museum, archives, and education communities will provide guidance and direction to the development, monitor progress being made, and make recommendations for the future.

Local museums have participated in preliminary work to date and are contributing to the training and evaluation of students interning in their settings. Student evaluation of the program and follow-up of their post-graduate activities will be conducted.

A newsletter to inform the photogrammetry, museum, and archives communities of our project will be distributed periodically and feedback sought from those who receive the newsletter.

MATERIALS:

A report of the activities involved in developing such a project will be compiled to provide guidelines for any institution which may wish to implement such a program.

Specific curriculum combinations and curriculum packages will be developed for distribution from the college.

Audio-visual materials which assist the museum and archives communities in understanding the use of photogrammetry in their settings will be produced.

PROBLEMS:

A major task to accomplish in this project is to increase the awareness of the potential users of close range photogrammetry throughout the United States regarding the immense contributions such technicians could make to their staffs. Unfortunately, the problem of what close range photogrammetry is, what it does, and how it can help them is not understood by the majority of the museum and archives personnel. This problem of articulation between the engineering science of close range photogrammetry and the social sciences requires a time of incubation. Our quarterly newsletter has been one of our major methods of increasing awareness of this technology. This past year we have had three workshops at different universities also to disseminate this information.

We have found from our experience that we must apply ourselves to the problems of cost analysis and viability.

PROBLEMS (cont):

(1) Cost analysis. Before products can be considered by users, they must have cost information. Unfortunately, the provisions under this grant do not provide the resources to contend with this problem.

(2) Viability. It seems to us it will be advisable to use photogrammetry to document some projects that have been recorded traditionally in order to compare our end products in terms of cost, accuracy, and suitability to projects done by the usual methods of hand documentation.

February, 1977

PROJECT NUMBER: SED 74-22283 **AMOUNT AWARDED:** $103,800

DATE AWARDED: January 1, 1975 **DURATION:** 24 months

PROJECT TITLE: DESIGN AND EVAUATION OF A PROGRAM FOR TRAINING TUTORS IN INDIVIDUALIZED COURSES

PROJECT DIRECTOR: Robert B. Kozma, Ph.D.

PROJECT ADDRESS: Center for Research on Learning and Teaching
109 E. Madison Street
Ann Arbor, Michigan 48109

TELEPHONE: 313 - 763-2367

PURPOSE:

The purpose of this project is to develop materials that will increase the effectiveness of tutors or proctors in courses taught by Keller's Personalized System of Instruction (PSI); and to conduct research on the use of proctors. The program for training proctors includes a validated instructional manual that is designed to help proctors in their three functions in a PSI course: quiz evaluator, tutor and instructional assistant.

AUDIENCE:

The proctor training program is intended for use with college undergraduate peer proctors in individualized courses. The program was developed specifically for PSI proctors but includes principals of instruction and diagnosis useful for training proctors and tutors in all types of situations. The training program is relevant to proctoring in a variety of subject matter areas.

INNOVATION:

The success of an individualized course hinges on the adequacy of the instructor's written materials and on the performance of his staff of proctors. Instructors have extensive resources that they can draw on in preparing written materials but the preparation and management of a staff of undergraduate proctors remains a problem for most instructors. Although most proctors in PSI courses are given academic credit for supervised teaching in a discipline, there are almost no written resources for the instructor to use in training proctors. Previous materials designed for proctors focus mainly on the formal procedures in personalized courses, and do not cover principles of instructional prescription and diagnosis. In addition, most instructors have limited internal resources

INNOVATION - continued

to draw upon; few have worked as proctors themselves. The basic goal of this project has been to design a model program for proctor training and to collect basic data on the impact of the materials on the proctoring experience.

EVALUATION:

During the 1975-76 academic year a set of materials entitled "Manual for PSI Proctors" was developed for field testing and formative evaluation. The materials were used at seven different universities around the country, and a controlled study was conducted at Bowling Green State University in Ohio. Analysis of the data showed that trained proctors learned the information in the manual, but the training did not change their performance. Since no differences were found in attitudes or behavior of trained and untrained proctors, it could not be expected that the proctor training would result in improved student performance or attitudes.

A second version of the manual entitled "Guide for PSI Proctors" was developed and field tested in 14 institutions. A number of changes were made in the new version in response to the findings of the previous field tests. These changes included emphasis of the behavioral aspects of the training; reduction of the number of behaviors to make it more manageable for proctors; inclusion of role playing as part of the training material; a maintenance system which will give the proctors periodic feedback on their behavior. Analysis of the data show that the revised Guide, when used as suggested, does bring about changes in the proctor behavior. It is still to be determined if these changes in the proctor behavior result in differences between the students using trained and untrained proctors.

MATERIALS:

When completed the project will have available a manual that instructors can use in training their proctors. The Guide for PSI Proctors is written in a PSI format with readings, study guides and mastery quizzes. Also available will be a report of the final results of this study to guide the instructors in the best use of the proctor training materials. The training materials will all be available in the Fall of 1977 through the Center for Personalized Instruction at Georgetown University, Washington, D. C.

PROBLEMS:

The training materials were envisioned as a manual that was general enough to be useful to all proctors, and were to include consumable workbooks specific to individual disciplines. We soon learned that to be specific enough in

PROBLEMS - continued

one area of a discipline made it difficult for those students less specialized; and that to have consumable workbooks for every discipline was unrealistic. Through many trials and errors, and many simplifications of the original plan we decided on materials that are general enough for proctors in all disciplines. We found the basic concepts of good proctoring to be universal, with brevity, relevance and simplicity all adding to the acceptance and wide use of the proctor training materials. We have had 35 different instructors use our materials in 17 different disciplines ranging from English classes to advanced mathematics at 23 different institutes across the country. Several instructors have continued using the materials through several revisions.

Another problem we have encountered is finding situations where controlled studies could be done with trained and untrained proctors. Although we have had a great deal of cooperation and enthusiasm from instructors across the country in using the different revisions of the training package, few would consent to training only half of their proctors for comparison studies. They felt that all their proctors would benefit from the proctor training and did not want to exclude them from the experience. Consequently, our controlled studies were limited to a few courses, and subsequent comparative results are not as generalizable as we would have liked.

PROJECT NUMBER: SED 69-01071 A13 **AMOUNT AWARDED:** $796,000.00

DATE AWARDED: March 1, 1976 **DURATION:** 17 months

PROJECT TITLE: UNIFIED SCIENCES AND MATHEMATICS FOR ELEMENTARY SCHOOLS

PROJECT DIRECTOR: Earle L. Lomon

PROJECT ADDRESS:
Education Development Center
55 Chapel Street, Newton, Massachusetts 02160
Phone Number: 617-969-7100

PURPOSE:

The USMES project is finishing development of twenty-six interdisciplinary units for use in elementary schools, which provide opportunities for students to learn the process of solving practical problems while acquiring relevant skills. Inherent in the program is the notion that children learn problem-solving skills by involvement with a problem that is real to them. The materials are based on a belief that problem-solving is an important skill to be learned and that much mathematics, science, social science and language arts may be learned within the context of student investigations of meaningful problems. Student-initiated activities revolve around "challenges" which present practical problems on which children can carry out in-depth investigations. The units are to be models of the real problem-solving style of learning and the impetus for having this type of learning taken up as a continuing effort in schools, but they will also be sufficient in number for school planners to design a curriculum for grades one to eight in which real problem solving plays an important role. A variety of resource materials designed to facilitate use of the program has been developed.

AUDIENCE:

Elementary and middle school students are expected to benefit most directly from the project. Working through the real problem-solving process affords them the opportunity to relate their development of basic skills to real-life situations; in other words, they become real problem solvers. Resource materials for students help them learn these skills and processes. Teachers and administrators as well are expected to benefit directly from the project. Resource materials for teachers and administrators direct their attention to classroom strategies, methods for integrating USMES into the school program, and document different kinds of initiatives and administrative strategies involved in conducting workshops for teachers.

INNOVATION:

Complex, long-range problem solving is a new area of learning in schools. It integrates many aspects of math, science, social science, and language arts while focusing on working toward a solution to a real problem. It emphasizes student involvement in planning, collecting and analyzing data, decision making, and active group work. It requires the teacher to assume the special role of coordinator and facilitator.

Because real problem solving is not an established discipline in the schools, the resources that have been developed and the strategies for developing these materials are unique. Materials are based on detailed logs and reports written by teachers and students engaged in an USMES challenge in their classrooms. Resource books list skills and concepts that arise in problem-solving activities. Another unique feature is the Design Lab--a central location for tools, materials, and workshop space--which gives students the opportunity to design and construct materials which contribute to and enhance their investigations of a solution to a real problem.

EVALUATION:

The evaluation of the effects of USMES is still in progress. Results to date, from both internal and external studies, support the basic assumptions of the instructional strategy and materials. Tests of real problem-solving abilities have indicated that USMES has a positive effect, but work remains to be done on development of appropriate and easily-used instruments. Results from standardized achievement tests in computation and reading indicate that USMES classes not only do as well, but possibly better than traditional classes in the key area of basics. Extensive interviews by outside evaluators and analysis of classroom activity have confirmed that the USMES program strongly affects the attitudes and behaviors of both teachers and students in positive ways.

Currently, the project is conducting three studies to learn more about USMES students, schools, and resource teams. The studies of students and schools are being conducted in four USMES schools, markedly different in size, structure, and setting. These two studies examine the impact of USMES on school programs and operations and its effects on student learning. The third study focuses on fifteen USMES resource teams in twelve states; these were selected from the total number of teams trained over the last four years. The study examines the effectiveness of the dissemination and implementation strategies teams have used to bring USMES to classrooms in their districts or regions and the factors that have facilitated or impeded their implementation activities.

MATERIALS:

In addition to the USMES Guide which gives the overall view of the project philosophy and materials, twenty-six Teacher Resource Books will have been developed by the termination of the project (summer 1977). Title are: Advertising; Bicycle Transportation; Classroom Design; Classroom Management; Consumer Research; Describing People; Design Lab Design; Designing for Human Proportions; Eating in School; Getting There; Growing Plants; Manufacturing; Mass Communications; Nature Trails; Orientation; Pedestrian Crossings; Play Area Design and Use; Protecting Property; School Rules; School Supplies; School Zoo; Soft Drink Design; Traffic Flow; Using Free Time; Ways to Learn/Teach; and Weather Predictions. Cartoon-style "How To" Booklets for primary children are available, covering topics in collecting data, measuring, simplifying data, graphing, working with electricity, and constructing homes for small animals. "How To" Cards for intermediate students covering the same topics and some additional topics are also available. A Design Lab Manual for school personnel is available, as are Design Lab "How To" Cards for students which include photographs and sketches of the tools and ways to use them. Preparing People for USMES: An Implementation Resource Book provides information on successful dissemination strategies. Trial editions of these materials are available through the project office. (Preliminary versions of (i) Background Papers for teachers which provide information not contained in the "How To" materials, and (ii) videotapes which can be used in informational meetings and workshops are available upon request.)

PROBLEMS:

The current unavailability of district and federal funds for purposes of implementation has seriously curtailed the training of new personnel in the use of USMES. Resource personnel, trained with previously available funds, are continuing to use as many local resources as possible to inform and train others to use USMES.

Solicitations for a publisher has met with little success to date. Because most of the USMES materials are teacher resource books, as opposed to materials for individual students, publishers seem to find it economically unfeasible to undertake. The project is currently investigating alternative distribution/publication plans that might prove feasible for long-range distribution should the project not be successful in attracting a publisher.

February 1977

Engineering, Math
and Science

PROJECT NUMBER: SED74-18479 A02 **AMOUNT AWARDED:** $83,800

DATE AWARDED: JULY 1, 1974 **DURATION:** 36 MONTHS

PROJECT TITLE: AN EXPERIMENT IN TEST IMPLEMENTATION OF A COMPREHENSIVE MATH AND SCIENCE ALTERNATIVE SCHOOL PROGRAM IN URBAN VOCATIONAL HIGH SCHOOLS WITH HIGH MINORITY STUDENT ENROLLMENT

PROJECT DIRECTOR (s): Gilbert J. Lopez and Melton Miller

PROJECT ADDRESS:
School of Education,
University of Mass.
Amherst, Mass. 01003
Area Code (413) 545-0275

PURPOSE:

This project, for brevity, named the Comprehensive Math and Science Program (CMSP) is an action oriented experimental project which is developing and testing intervention strategies for increasing the pool of minority students who can qualify for admission into two and four year college engineering programs. The CMSP is one of many on going projects nationwide which is addressing the pervasive problem of the unusually low representation of american minority citizens of black, hispanic, and native-american background in the science and engineering professions. The CMSP basic project goal is to develop and test an organizational model which utilizes the institutional resources of the secondary school, college, and private business to enhance high school math and science instruction, provide reality based post-secondary and career counseling, and foster a comprehensive evaluation process which allows participating high school students to demonstrate (longitudinally) their math and problem solving application skills and their willingness to dedicate time and effort to a two year, after school hour, program.

AUDIENCE:

The CMSP is concentrating its project effort at eleventh and twelfth grade high school students in inner city secondary schools with high minority enrollment. At present, ten high schools located in the cities of Springfield, Ma., Hartford and Bridgeport, Ct., and New York, N.Y., are participating in the project. In the first year of the project, over fifty students participated in the project and on the basis of their performance in the project, more than one-half of the students were admitted into two year and four year engineering college programs. A second round of project activities was begun on an expanded scale in the spring of 1976, increasing the number of participating students to 100. A major objective in the project expansion was the organizational development of the project into a parallel effort in order to minimize the probabilities of chance outcomes and provide a test base for project evaluation through comparative analysis. The organizational development has resulted in the structuring of six project networks which pair one or more participating high schools with a local college of engineering and an engineering business firm. These six networks are engaged in testing the model with the same organizational and programmatic format and the same project time schedule.

INNOVATION:

Fundamental to the design of the CMSP model is the general recognition that disadvantaged minority students, because of the lack of role models and complex socioeconomic factors,do not receive the technical academic guidance and career counseling necessary for consideration of careers in Engineering and Science. As such, a major project strategy is the development of an organizational plan which significantly increases encounters and interaction between "potential" students and professionals who serve as their "advocates". This organizational construct, if proven effective, will essentially fill the "counseling and advisement" gap that now precludes "potential" students from receiving timely encouragement and direction at the important last stages of their high school tenure.

The organizational plan is based on a triumverate organizational format that formally introduces representatives from higher education and private industry into the high school environment. Inherent in this design approach is a program team concept for operationalizing the "advocacy" role to be played by the representatives from higher education and private industry without imposing on the high school academic and administrative structure. The objective is to formulate a team construct whereby these representatives can formally join with high school staff persons to direct, counsel and evaluate students participating in specific program model activities.

The CMSP model is designed to he test implemented over a two year period, covering the eleventh and twelfth high school academic years. The model is organized in four sequential phases, as follows:

PHASE I-AWARENESS AND ORIENTATION-FALL SEMESTER, 11th YEAR

This first phase includes formal presentations to 11th year students which focus on the career opportunities in Engineering and Science, the prerequisites of engineering college studies and details of the CSMP activities and student commitment.

PHASE II-TESTING AND PRE-EVALUATION-SPRING SEMESTER, 11th YEAR

The second phase of the program is called the Math Aptitude Program (MAP), and is designed around a project oriented curriculum which allows participating students to demonstrate their math and communication skills potential.

PHASE III - QUALIFICATION-FALL AND SPRING SEMESTER, 12th YEAR

This phase of the model consists of two components; 1) A modularized mastery learning program in precalculus that is directed jointly by a high school math teacher and an engineering or math college professor. The math program is organized with math module presentations at the high school and weekly visitations by participating students to the locally paired college for testing, review and math laboratories. The college professor, in this capacity, serves as the feedback element to insure that the students are mastering math performance objectives at a college level. 2) An integrated Business and Technology curriculum which is directed by a professional engineer that introduces and exposes students to the practical realities of engineering project developments. The lectures given at monthly intervals are followed by visitations to engineering or business firms where students can experience the specific lecture topic in real world dimensions.

PHASE IV - STUDENT EVALUATION - SPRING SEMESTER, 12th YEAR

A three criteria evaluation progress is being utilized to assess participating student performance in the project: 1) Math Proficiency 2) Research and Problem Solving Application Skills 3) Work Effort Devoted to Project Activities. Each of these criteria has a reference measure related to specific program elements in the project. The project network team made up of representatives from secondary, post-secondary, and business who direct students in the project, also function as an evaluation panel.

If the CMSP model proves to be viable, it could be utilized in other educational settings for making sizable increases in the pool of qualifiable minority students for engineering colleges. The potential of the project has been partially demonstrated by the students who have been admitted into engineering colleges as a result of the program. Their retention and performance to date (three semesters work completed) is comparable to students admitted to engineering colleges by traditional admission processes.

EVALUATION:

The CMSP was one of eleven projects funded in 1974 to address the problems of minorities in Engineering. As part of the overall program plan, the NSF retained a third party, the American Institute for Research, to evaluate the effectiveness of all eleven projects. A full technical report which has been recently published describes the eleven projects in historical perspective and gives comparisons on the effectiveness of the various project approaches. In this report of first year object activities, the CMSP was rated as the most effective of the eleven programs in developing and testing methods for increasing the access of minority students to careers in Science and Technology.

The basic internal plan for evaluating the effectiveness of the CMSP is a comparative analysis of the project performance of the six networks in meeting established project goals. The characteristics of the institutions making up each network are sufficiently different to give a reasonable test of the common methodologies employed in the CMSP model. In addition, three other criteria are being used to determine project effectiveness: 1) On going tracking of the performance of students admitted to engineering colleges as a result of the CMSP. 2) The willingness of the institutions participating in the project to financially support various elements of the project. 3) The integration of developed matherials and CMSP program designs into elective school programs at the high schools.

MATERIALS:

A project manual will be prepared at the end of the project that could serve as a guide for implementating the model in other demographic settings. This manual will be organized to fully detail the four phases of the CMSP, including intervention methods and strategies, curriculum utilized in various elements of the model and the student evaluation process. This manual upon completion will be forwarded to the NSF and it is presumed that copies will be available for distribution.

PROBLEMS:

The non-traditional nature of the project, which focuses on identifying and evaluating potential students through a demonstrative process has sometimes created problems of understanding with a project staff generally oriented towards the traditional processes of academic student assessment. Project staff have had a tendency to lead and teach students through the various elements of the project rather than guide students in using their own initiative in meeting performance objectives. This problem is being overcome by increasing the number of project staff meetings where program strategies and student-staff encounters are reviewed and discussed in detail.

Communication between institutional representatives of the high schools, colleges, and businesses is another problem which was anticipated because of the inherent differences in the philosophies and goals of the participating institutions. In this instance, the goals of the project have been delineated in detail with defined responsibilities for all members of the project network team which has helped minimize overlap and conflict.

February 1977

PROJECT NUMBER: SED 71-01952 **AMOUNT AWARDED:** $593,421

DATE AWARDED: April 1, 1971 **DURATION:** 78 months

PROJECT TITLE: COMPUTER ORIENTED MATERIALS PRODUCED FOR UNDERGRADUATE TEACHING (COMPUTe)

PROJECT DIRECTOR: Arthur W. Luehrmann, Jr.

PROJECT ADDRESS:
Project COMPUTe
Office of Academic Computing
Kiewit Computation Center
Dartmouth College
Hanover, NH 03755
Tel. (603) 646-2923

PURPOSE:

The purposes of this project were to identify curricular materials related to the use of the computer in teaching traditional subjects; to assist authors in bringing these materials to publishable quality; and finally to seek commercial publication. The project is based in part on the premise that commercial publishers are unwilling to gamble on texts that include computing unless there is strong evidence that such texts have large market potential.

AUDIENCE:

The materials and texts are designed for college-level courses in mathematics and the physical and social sciences. A few of the materials would be appropriate for well-prepared and well-motivated secondary school students.

INNOVATION:

The major innovation of this project was to develop a publishing agreement whereby authors could be partly supported by the NSF during the final stages of their manuscript preparation, and still be able to receive royalty payments from an eventual publisher. The texts were selected by competitive evaluation from among those submitted in response to an RFP.

EVALUATION:

In addition to applying the normal publishing standards for editing, makeup, and appearance, the principal means of evaluating the materials produced by this project will be their performance in the market place. Preliminary sales data on texts already published locally is available.

MATERIALS:

Twenty-five (25) products have been developed in the form of traditional textbook materials, a few suited for a full course, most designed to be used in conjunction with other texts of the instructor's choosing. These titles are grouped as follows: Environmental Studies - 6; Geography and Urban Studies - 5; Mathematics and Logic - 6; Physics - 4; Psychology - 3; Chemistry - 1. Program packages (BASIC or FORTRAN, depending on text) in exportable form accompany each text. Information about available texts may be obtained from David McKay Co., Inc., College Department, 750 Third Avenue, New York, NY 10017.

PROBLEMS:

The principal problem was securing a commercial publishing contract for 25 computer-related instructional texts. Thirty months of serious discussions and negotiation with publishers went into the final agreement; eighteen months were involved once an exclusive publisher was selected. Significant delays ensued over the publisher's concern about the market for such material and their lawyer's determination to protect against loss. At the other end, a constantly changing structure and atmosphere at the National Science Foundation impeded approval of the proposed publishing contract. All these obstacles were overcome by a persistence based on belief in the products and the need to make them available on the commercial market in order to prove their viability.

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PROJECT TITLE: HUMAN SCIENCES PROGRAM

PROJECT DIRECTOR: Dr. William V. Mayer

PROJECT ADDRESS: Biological Sciences Curriculum Study
P. O. Box 930
Boulder, Colorado 80306
(303) 666-6558

PURPOSE:

To make available a set of curriculum materials with subject matter drawn largely from the biological and behavioral sciences that specifically meet the unique needs of the emerging adolescent and that follow the guidelines established as a result of a needs assessment study conducted during 1966-69. A three year interdisciplinary program has been developed and field tested toward this end. The materials will be revised based upon the field test results and the first materials should be available commercially to schools sometime in 1978.

AUDIENCE:

The program is specifically designed for the emerging adolescent (roughly ages 10 to 14). It seeks to facilitate the transition of students from lower levels of cognitive and affective development to higher levels as they mature from childhood to adolescence.

The modules comprising the program were designed to conform to the development of students rather than to grade sequences in schools. Thus the materials will be appropriate at junior high schools, middle schools, intermediate schools and other organizational structures that educate 10 to 14 year olds.

INNOVATION:

Choice and flexibility are important characteristics of the program. Development and learning are specific to individuals. Students differ in learning style, process bias, cognitive and affective maturity, perception and motivation, as well as in many other ways. To accommodate these diversities, the Human Sciences curriculum provides a variety and abundance of learning activities related to a topic. Students are free to choose among the alternatives. Instructional activities are designed to serve as a stimulus to learning rather than as a prescription for what is to be learned. Some activities are designed to initiate learning and provide useful experience related to concepts underlying the activity. There are also activities that develop a skill, identify and explore values, engage the student in problem-solving or decision-making processes, stimulate group interactions and provide an integrative experience. Students select where to begin on a problem and then pace and evaluate their own learning. In this way, the Human Sciences Program accommodates the unique characteristics of each person, assures a high level of motivation and places an increased responsibility for learning on the student.

Teachers and administrators have both choice and flexibility in the use of the program at a given level because the modules designed for that level have no linearity. Because of the flexibility of the packaging of the program components and thematic structure of the curriculum, teachers and students can modify the program to meet local needs by:

- adding activities that have a local context or meet local learning objectives
- deleting activities either not germane to the local student population or consider inappropriate
- using a module in an already identified course of study
- using modules in interdisciplinary teaming situations.

EVALUATION:

The program materials have been field tested in a variety of test sites across the country. Feedback of many varieties was collected from teachers, administrators, students and parents at these test sites. Data were collected to determine student achievement as well as their affective reactions to the materials. In addition, the program materials have been analyzed for reading level, reviewed at a public review conference and reviewed at two content review conferences. The entire pool of evaluation data will be analyzed and utilized in the revision of the program materials.

MATERIALS:

The materials are organized into fifteen modules each focused on a central theme or unifying idea. (A module consists of all the materials, equipment, print matter, audio-visuals and teacher materials, equipment, print matter, audio-visuals and teacher materials necessary for 6 to 9 weeks of instruction when students are allowed to work with the materials approximately five hours a week.) In the field test versions the materials were housed in a module cart which served as the "hub" of the Human Sciences classroom. The activity cards, from which students made their choices, were displayed in a library rack arrangement on the top half of the cart. The materials for each activity were packed in labeled drawers in the bottom half of the module cart. As each new module arrived the old materials were simply removed and stored (in the drawer units) and the new materials were placed on the cart. This materials packaging arrangement proved to be very effective in solving classroom management problems relative to equipment.

The final program materials will contain the following:

- 15 modules with student activity cards and materials for completing the activities.

LEVEL I

Growing
Behavior
Learning
Motion
Sense or Nonsense?
Surroundings

LEVEL II

Rules
Where Do I Fit?
Interrelationships
Perception
Reproduction

LEVEL III

Change
Invention
Feeling Fit
Knowing

- Student evaluation materials relative to each module.
- Comprehensive Teacher's Guides for each module.
- Management Resource Materials for individual teachers or groups of teachers appropriate to the teaching of Human Sciences.

PROBLEMS:

The teacher role in teaching Human Sciences is different from that in a traditional structured classroom environment. The teacher's role is one of encouraging students, participating in activities, clarifying problems, assisting in the interpretation of results, and questioning and probing to stimulate the intellectual growth of students. Communicating this role clearly and providing materials to help teachers assimilate this model without the personal contact utilized during the field test will pose a challenge during the final revision.

The final cost of the commercial modules will be an important consideration for maximizing the impact of the program. The mark up required by commercial distributors will require adjustments during the final revision of the materials.

Engineering, all branches
Social Sciences
Interdisciplinary

PROJECT NUMBER: SED 75-17159 AMOUNT AWARDED: $138,910

DATE AWARDED: June 15, 1975 DURATION: 36 months

PROJECT TITLE: SOCIOTECHNICAL SYSTEMS DESIGN PROGRAM

PROJECT DIRECTOR: Gerald Nadler

PROJECT ADDRESS: University of Wisconsin-Madison
Research Administration-Financial
750 University Avenue
Madison, Wisconsin 53706
Phone No. 608/262-3822

PURPOSE:

The Sociotechnical Systems Design (STSD) Program is being developed within the College of Engineering in consultation with social science faculty members. Its purpose is to provide instruction in two areas for nonengineers, especially humanities and social science students. The first area deals with technological information. The second area involves certain tools and techniques used by engineers which are believed to be of potential value to such nonengineers in pursuing their careers.

The STSD Program is to consist of 12 credits. Two core courses are Systems Techniques and Design Concepts. An Integrative Seminar course will accomplish its purpose through project work. The remaining course is to be selected to provide background in some specific technological area.

The STSD Program currently is planned to be only a formalized alternative interest area for nonengineers. Its purpose is to make available a coherent set of courses which can be taken in total or as individual courses. The total twelve credits may serve as a senior concentration, part of a Masters program, or a PhD minor.

AUDIENCE:

The STSD Program is being developed for those senior and graduate nonengineering students, especially in the humanities and social sciences, who desire instruction in selected technological areas and in analytical and design approaches characteristic of engineering.

INNOVATION:

We believe that certain of the approaches utilized by engineers are potentially valuable to social science students for future use in pursuing their careers. Thus, a major purpose of the program is to provide basic systems and design skills.

EVALUATION:

Five outcomes of the STSD program will be evaluated: (1) the STSD program package, (2) specific courses, syllabi, readings, etc., (3) students who have completed the program, (4) need statements on additional STSD requirements, and (5) student generated products. The methods for evaluation involve objective profile measures on students, as well as a national advisory committee review for outcomes such as 1, 2, and 4 and student review for outcomes 2, 3, 4 and 5. Specifically, the profile measures on students will consist of pre and post data on problem solving, personality classification, knowledge, application, etc.

MATERIALS:

A report at the completion of the project will contain information relative to the five outcomes and evaluation. Individual course outlines, exercise handouts, readings, bibliographies, examinations, and so on will be available for each course developed as part of the STSD program.

PROBLEMS:

Although not yet major for Wisconsin, we anticipate that a major problem elsewhere may involve the administrative processes whereby engineering courses for nonengineers need to be approved. In addition, flexibility is needed in permitting liberal arts students to take such courses for credit in their programs. Another problem may involve the form in which such courses are brought to the attention of nonengineering students, especially in the social sciences and humanities.

ADDITIONAL COMMENTS:

A letter to over 200 Deans of Engineering in the United States and Canada offered early transmittal of STSD materials as they are developed rather than waiting until the final report is available. Nearly 50% of the deans responded requesting such early material. The need being addressed by the program seems to be widespread.

February 1977

Statistics
Computer Science

PROJECT NUMBER: SED73-00164 A01 **AMOUNT AWARDED:** $91,355

DATE AWARDED: May 23, 1975 **DURATION:** 18 months (7/1/76 - 12/31/76, extended to 3/31/77.)

PROJECT TITLE: BAYESIAN STATISTICS AND INTERACTIVE COMPUTING SYSTEMS

PROJECT DIRECTOR: Melvin R. Novick

PROJECT ADDRESS:
Iowa Testing Programs
356 Lindquist Center
The University of Iowa
Iowa City, Iowa 52242

PURPOSE:

The purpose of this project is to develop and distribute a conversational language interactive computer-assisted data analysis (CADA) system designed to facilitate persons relatively inexpert in statistical methods, students as well as researchers, to analyze data more expertly through the use of Bayesian statistical methods. The programs are designed to lead the student and researcher step-by-step through a data analysis in much the same way as a computer-assisted instruction (CAI) program leads a student through an instructional sequence. The programs are thus considered to have both instructional and operational value.

AUDIENCE:

The system is intended for two audiences. On the one hand, the Computer-Assisted Data Analysis (CADA) Monitor is used to teach Bayesian statistical methods to students who have a minimal mathematical background. On the other, it provides educational administrators with easily used yet sophisticated methods of combining probabilities with utilities in order to produce coherent and effective decisions. The CADA Monitor is currently being used at 60 universities and institutions internationally.

INNOVATION:

The primary innovative feature of the CADA system is that the programs are all in the conversational mode (written in BASIC) and therefore accessible to students and educators who have no computer experience. CADA leads a user through a statistical analysis on a step-by-step basis so that he must "do things correctly" and thus learn only correct procedures. The CADA system makes use of the two major strengths of the computer -- computational speed and memory -- as adjuncts to the human thought process.

A further innovation of CADA is the integrated design of the system. Data are passed automatically from one module of an analysis to another. This design facilitates a high level of freedom of movement within a given analysis, so that sections of an analysis can be redone without the need to start from the beginning. This is accomplished by a sophisticated restart routine that gives the user a high degree of control over the analysis. Furthermore, this system is highly modularized so that new methods of analysis can be easily programmed using building blocks already available on the Monitor.

EVALUATION:

The CADA Monitor has been evaluated at various stages of development by D. V. Lindley, University College London; Ivo Molenaar, University of Groningen; and Donald Meyer, University of Pittsburgh. In addition, users of the programs provide ongoing evaluation as to the practicality of the system.

MATERIALS:

The project currently makes available 97 program modules covering various types of data analysis. The program package is available on paper tape, cards, diskette, or magnetic tape (9 track, 800 or 1600 BPI, EBCDIC or ASCII format or HP 2000 ACCESS format). In addition, the CADA Monitor includes a CADA manual, listing of programs, and the following technical bulletins:

Novick, M. R. High school attainment: An example of a computer-assisted Bayesian approach to data analysis. International Statistical Review, 1973, 41, 264-271.

Novick, M. R. A course in Bayesian statistics. The American Statistician, 1975, 29, 94-97.

Isaacs, G. L. Interdialect translatability of the BASIC programming language. ACT Technical Bulletin #11, 1973.

The system is available in the following dialects of BASIC:

HP 2000 ACCESS
IBM 370 VS
DEC 10
DEC 11
CDC Cyber

The translation to other dialects of BASIC is straightforward provided there is a formatted print statement, data file capability, and chaining capability, or a large user work-area where the whole Monitor can be loaded at once. All materials are available at nominal cost from Iowa Testing Programs, the University of Iowa, Iowa City, Iowa 52242.

PROBLEMS:

Our major problems relate to short word-length, slow computation, and limited disk capacity on certain mini-computers. This problem becomes more pressing as we undertake more complicated analyses. However major performance/cost increments in the areas mentioned above are occurring in new mini-computer releases. The strategy we have adopted in our software development is to anticipate some of these advances. Indeed our start on this project in 1971 was based on anticipated developments that have now occurred.

February 1977

PROJECT NUMBER: SED75-16420 AMOUNT AWARDED: $57,407

DATE AWARDED: June 1, 1975 DURATION: 24 months

PROJECT TITLE: ENERGY/ENVIRONMENTAL SYSTEMS AND MULTI-DISCIPLINARY TRAINING

PROJECT DIRECTOR: David Pimentel

PROJECT ADDRESS: Cornell University
Department of Entomology
Section of Ecology & Systematics
Comstock Hall, Room 50-A
Ithaca, New York 14853

PURPOSE:

The purpose of this project is to develop a curriculum that will provide students with the training and experience necessary to deal with complex energy/environmental systems. Multi-disciplinary approaches are essential in dealing effectively with relevant energy/environmental problems. The developed curriculum necessitated students from several disciplines to work together in task forces and focus their learning and research efforts upon current problems. This will aid students to design and devise methods for effective systems management of energy/environmental problems.

AUDIENCE:

Postdoctoral, predoctoral, and senior students of science and related disciplines of economics, sociology, engineering and urban planning benefit from this curriculum. The curriculum is adaptable to universities and colleges primarily with graduate programs.

INNOVATION:

The curriculum provides the opportunity for students representing different disciplines to focus their attention on relevant energy/environmental problems. The students in this way gain experience in understanding the general framework of complex problems. The reports produced by the students have been published in Science and BioScience and have been well accepted by the scientific community.

EVALUATION:

The project is being evaluated by a team of scientists from three universities and representing the disciplines of biology, physics, and engineering. The results will be used to revise and modify the curriculum.

MATERIALS:

The reports of the multi-disciplinary student task forces that have been published in Science and BioScience are available from the Project Director. The reports thus far published are:

Pimentel, D., L. E. Hurd, A. C. Bellotti, M. J. Forster, I. N. Oka, O. D. Sholes, and R. J. Whitman. 1973. Food production & the energy crisis. Science 182:443-449.

Pimentel, D., W. Dritschilo, J. Krummel, and J. Kutzman. 1975. Energy and land constraints in food-protein production. Science 190:754-761.

Pimentel, D., E. Terhune, R. Dyson-Hudson, S. Rochereau, R. Samis, E. Smith, D. Denman, D. Reifschneider and M. Shepard. 1976. Land degradation: effects on food and energy resources. Science 194:149-155.

Pimentel, D., E. Terhune, W. Dritschilo, D. Gallahan, N. Kinner, D. Nafus, R. Peterson, N. Zareh, J. Misiti and O Haber-Schaim. 1976. Pesticides, insects in foods, and cosmetic standards. BioScience (in press).

PROBLEMS:

The prime difficulty has been in obtaining a wide array of disciplines, particularly from the social sciences. This problem is slowly being overcome as the curriculum becomes better known.

PROJECT NUMBER: SED 74-21653 **AMOUNT AWARDED:** $92 195

DATE AWARDED: October, 1974 **DURATION:** 36 months

PROJECT TITLE: SUPPORT OF A UNIVERSITY CORE GROUP FOR EDUCATIONAL INNOVATION

PROJECT DIRECTOR: Professor F. Reif

PROJECT ADDRESS: Group in Science and Math Education
c/o Physics Department
University of California
Berkeley, California 94720
Phone number: 415-642-4070

PURPOSE:

The purpose of this project is to further, at the University of California in Berkeley, the development and activities of an interdisciplinary Group for the advancement of education. The Group seeks to attract good talent (both faculty and students) from the sciences to pursue serious work in education; to develop innovative modes of educational delivery at the University and outside; to undertake research dealing with instructional methods and underlying cognitive mechanisms; and to train doctoral students prepared for future careers in educational innovation. (The NSF support of the Group is used almost entirely for support of the work of some of these students.)

AUDIENCE:

The following audiences may be expected to benefit from this project: (1) Graduate students who, after being highly trained in a science as well as in education, obtain a special Ph.D. degree in science/math education and are prepared for future careers in educational innovation. (2) College (and other) students who can be expected to benefit directly through educational innovations and materials introduced through the efforts of the Group. (3) Faculty members at other educational institutions who may profit from the published educational work of the Group and who may also be helped indirectly in their own efforts to obtain greater legitimation for educational work undertaken by them.

INNOVATION:

Traditionally, universities engage in various teaching functions, but do not view their role in education as that of providing innovative intellectual leadership of high excellence. The Group seeks to overcome this precedent by considering education as a challenging applied science with much potential for significant development; by trying to involve the university more centrally in education, drawing on some good talent from the main university departments (rather than relying merely on traditional schools of education); and by offering a special Ph.D. degree in science and mathematics education to prepare students for future work in educational innovation. [Thus the Group strives to achieve some of the aims outlined in an article by F. Reif in Science, vol. 184, p. 537 (1974.]

EVALUATION:

The basic questions to be assessed are whether the Group is making significant progress in achieving its goals and whether it can, in fact, establish itself as a viable academic unit supported by the University of California on a secure and permanent basis. The University is presently carrying out a formal evaluation of the Group to answer these questions as well as to determine the prospects of future University support of the Group. This evaluation is being carried out by a special committee consisting of several faculty members from the Berkeley Campus and an educational expert from outside the University of California.

MATERIALS:

The project is not primarily intended to produce educational materials, but to further the development of the Group by supporting the work of some of its students. However, in this process there will be produced some Ph.D. dissertations resulting from the students' educational research or development work, some published articles in journals, and some teaching materials resulting from the research efforts of these students.

PROBLEMS:

There are many problems in establishing an effective university group for the advancement of education. In particular, it is difficult to provide good intellectual leadership and cohesiveness in an interdisciplinary undertaking; to attract to education some first-rate talent which is both committed and competent; to persuade universities to take education seriously, instead of being satisfied with routine teaching activities; and to obtain stable financial and institutional support for a new academic unit in times when universities are in a no-growth situation and when budgets are being cut.

May 1977

Elementary science, mathematics, and social science

PROJECT NUMBER: SED 74-00542 A01 **AMOUNT AWARDED:** $179,100.

DATE AWARDED: March 22, 1974 **DURATION:** 39 months

PROJECT TITLE: EVALUATION OF UNIFIED SCIENCE AND MATHEMATICS FOR ELEMENTARY SCHOOLS

PROJECT DIRECTOR: Mary H. Shann, Associate Professor

PROJECT ADDRESS:
Boston University
School of Education
232 Bay State Road
Boston, Massachusetts 02215
Telephone: (617) 353-2573

PURPOSE:
The purpose of this project was to evaluate the curriculum called USMES, whose independent development has also been funded by NSF and whose purpose has been the creation and trial implementation of interdisciplinary units which engage elementary school children in long-range investigations of real, practical problems taken from their school/community environments.

During the first year of data collection, the 1973-74 academic year, the evaluation project addressed broad issues about USMES development and implementation: teachers' appraisals of the USMES curriculum and its materials; the effectiveness of USMES teacher training models; the patterns of actual USMES usage; and indirect effects of USMES implementation.

During the data collection for 1974-75, the evaluation focused on the assessment of student effects of the program--their basic skill development, their advancement in problem solving skills, and changes in their attitudes toward science, mathematics, problem solving, and the style of education embodied in the USMES philosophy. A pre-test, post-test control group design governed the comparisons based on a national sample of 40 USMES classes and 40 control classes. The actual learning activities and instructional content in science and mathematics for both groups were monitored as well.

AUDIENCE:
The evaluations were designed to provide information and make recommendations regarding USMES to NSF and to the developers of USMES. Assessments of the effects of USMES on students were addressed to other interest groups as well: current and prospective USMES teacher users; administrators at the building,

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district, and state levels; curriculum developers, evaluators, and researchers in science and mathematics education.

INNOVATION:
The USMES project and its philosophy reflect many current emphases in science and mathematics education--early readiness of the child to develop competence in problem solving; and interdisciplinary, student-centered investigations of real, complex problems in which the teacher, acting only as a coordinator and collaborator, must adopt a new, more indirect style of teaching. Measurement of the goals of USMES in the areas of problem solving and attitudes, if not basic skills, required new instruments appropriate to the ages of the children and the USMES emphasis on real, practical, complex problems.

Intensive efforts were directed toward developing instruments to measure problem solving, and four techniques resulted: the Picnic Problem and the Playground Problem as parallel forms of a test to assess small group efforts to solve simulated, life-like problems of interest to children; a multiple-choice, paper-and-pencil Test of Problem Solving Skills (TOPSS) to measure component skills with contextual items; and PROFILES, and interview/observation technique to assess problem solving processes in children. In addition, an attitude scale was developed and pilot tested to measure children's attitudes toward science, mathematics, and problem solving, and an observational technique was developed to assess the nature and frequency of problem solving activities, student-centered behaviors, and teacher-centered activities in USMES and control classes. These instruments may be appropriate intact or with slight modifications for the evaluation of other problem solving curricula.

EVALUATION:
This project is itself an evaluation project, but it too sought advice on design, instrumentation, data analysis, and report writing from the members of its advisory board and from other experts in problem solving, science and mathematics education, and program evaluation.

MATERIALS:
Two major reports on the results of the USMES evaluation are available from the ERIC Clearinghouse for Educational Tests, Measurement, and Evaluation at the Educational Testing Service, Princeton, New Jersey 08540. These are entitled: (a) "An Evaluation of Unified Science and Mathematics for Elementary Schools

During the 1973-74 School Year," 247 pp., August, 1975; and (b) "Student Effects of an Interdisciplinary Curriculum for Real Problem Solving: The 1974-75 USMES Evaluation," 376 pp., December, 1975. Summaries of these reports have peen prepared. A document on "Measuring Problem Solving Skills and Processes in Elementary School Children," June, 1976 is also available from ERIC at ETS. In addition, articles on the results of the USMES evaluation and on the new instruments and methodologies developed to evaluate USMES are being prepared for submission to professional journals in science and mathematics education. All reports and articles are authored by the Project Director.

PROBLEMS:
Research on complex problem solving has been hampered by the enormous, amorphous state of the literature on this ill-defined construct and by the inadequacy of measuring instruments and observational assessment techniques to study problem solving behaviors. The USMES Evaluation Project had to direct major efforts toward new instrument development in problem solving in order to address its primary mission, the evaluation of USMES. Furthermore, some teachers, principals, communities, and districts in the sample were reluctant to submit to the demands of the testing and observation programs which a comprehensive evaluation imposed. How the USMES evaluation resolved these problems or managed these difficulties are described in the evaluation reports, and the accounts may be of interest for the large-scale evaluation of other curricula.

February, 1977

Integrated Science Program

PROJECT NUMBER: SED 76-01243 **AMOUNT AWARDED:** $374,000

DATE AWARDED: June 15, 1976 **DURATION:** 36 months

PROJECT TITLE: DEVELOPMENT AND TRIAL OF AN INTEGRATED UNDERGRADUATE SCIENCE MAJOR PROGRAM

PROJECT DIRECTOR: Robert C. Speed

PROJECT ADDRESS:
Integrated Science Program
Dearborn Observatory
Northwestern University
Evanston, Illinois 60201
Phone No.: 312/492-7219

PURPOSE:

The purpose of the project is the implementation and evaluation of a special 3-year, degree-producing program of natural sciences and mathematics that embodies rigor, breadth, and integration. The program will test assertions that the knowledge and motivation in science can best be supplied to achieving students through an integrated and accelerated approach. Program evaluation will indicate the virtues of such a program, the problems in execution, and the feasibility of its acceptance on a national scale.

AUDIENCE:

Products of this study will be used by institutions of higher educations, chiefly those involved in career-preparatory science education. An equally important audience is the pool of university-bound, science-motivated students who may wish to take their education in the Integrated Science Program at Northwestern or equivalent program which may emerge at other institutions in the future.

INNOVATION:

ISP is a newly created curriculum that integrates the natural sciences and mathematics over a 3-year interval and leads to a B.A. in Science. The philosophical framework is that there is a strong common base among science disciplines and that the exercise of intellect, analysis, and innovation and the organization of knowledge are more effectively accomplished by emphasizing the common base rather than conventions and techniques unique to each discipline.

The undergraduate years are the time for students, especially those gifted intellectually, to learn deeply about the full realm of science. The appropriate time to specialize for such students is in graduate school. As a corollary, we regard academic work beyond the B.A. as essential for the practicing scientist, whether from ISP or a conventional discipline. Thus, ISP is designed to provide an outstanding platform for graduate or professional studies. We anticipate that ISP graduates will

will pursue with confidence and interest an array of challenging scientific problems that require knowledge and outlook beyond the scope of the typical traditional researcher. Besides broad topical coverage, ISP students will have in common a rigorous approach; moreover, they will have been exposed to conceptual problems as well as to experimental, observational, and computational techniques.

We are convinced that integrated undergraduate science education is one way to draw the nation's best student talent into the sciences. The anticipated success of ISP thus may induce other major universities to adopt an integrated approach in years to come. The potential pitfall is not in concept but in the entrenchment of university scientists in traditional departmentalism.

The ISP curriculum begins with a four quarter core sequence of mathematics through partial differential equations, classical physics, and chemistry (general, organic, and physical). The core is followed by four concurrent derivative sequences: life sciences (biochemistry, micro- and macro-biological systems), physical science (earth, solar and stellar systems), higher mathematics (real analysis, probability, complex variables), and modern physics. Large flexibility in educational paths and majors will be available to ISP students, especially if all or part of a fourth year is spent at Northwestern. Options are as follows: 1) B.A. in Science, the ISP degree, 2) three year Honors degree by transfer from ISP to Honors program in certain science departments after completion of the core sequence, 3) dual major in four years: the ISP major and a traditional science department major, 4) dual major in four years: the ISP degree and an ad hoc or interdisciplinary science major, and 5) two degrees in four years: the ISP degree together with a Master's degree.

EVALUATION:

Project is being evaluated by continuing assessment of program goals, curriculum design, student performance, faculty interaction, acceptability and transferability of the ISP principle to universities, and acceptability of ISP graduates to graduate and professional schools. The evaluation study is being conducted by faculty and staff of the Evaluation Research Program of the Department of Psychology. Northwestern University Groups participating in the assessment are ISP faculty, ISP students, other science students at Northwestern, and departmental admissions officers at other schools. Information is gained by questionnaire surveys.

MATERIALS:

Major output will be detailed curriculum syllabi available in summer, 1978, on the ISP program. A copy will be made available to interested parties on request by the Program Director at Northwestern. Newsletters are issued semi-annually. Technical papers on evaluation studies will be published in appropriate journals.

PROBLEMS:

None

March 1977

Psychology
Engineering
Education

PROJECT TITLE: VISUAL SEARCH ACTIVITY: A TOOL FOR THE EVALUATION AND DEVELOPMENT OF COMPUTER-ASSISTED READING INSTRUCTION PROGRAMS.

PROJECT DIRECTOR: John A. Stern, Ph.D.

PROJECT ADDRESS: Washington University Behavior Research Lab
1420 Grattan Street, St. Louis, MO 63104

PURPOSE:

The purpose of this project is to explore the applicability of computers to reading instruction, reading skill development and reading remediation. Specifically, we are concerned with the use of computer-based on-line evaluation of eye movements (EM) and other aspects of visual search to modify aspects of computer generated displays utilized in reading instruction. Our focus is on this problem as well as the utilization of eye movement information to make inferences about cognitive information strategies used by readers at different levels of reading skill development and reading for different purposes.

AUDIENCE:

This research is relevant to the evolving use of computers as instructional devices, as well as the development of more skill based remediation procedures in the field of reading instruction.

INNOVATION:

An example or two of the applications of our procedures to reading may be the best way to describe innovations. There are, otherwise, reasonably competent readers who depend more on head than eye movements to place reading material into foveal vision. This is an inefficient, slow, and fatiguing method of reading. Most readers utilizing this procedure are not really aware of this "habit". Remediation involves a) the sensing of head movements associated with reading (return from end of line to beginning of new line); b) storage of stories in a computer which can be programmed to be presented with few (narrow) or many characters per line; c) starting with a narrow line width we sense head movements, if their incidence is below a defined level the next page of computer displayed text utilizes more characters per line; d) training is continued until reader can handle normal line width displays with minimal head movements. We have found to date that this procedure is effective in teaching readers to reduce head movements and that the inhibition of head movements generalize from the computer displayed text to printed text. We are currently following a number of students who have been trained to reduce head movements to see if the reduction persists for a number of months after training (without additional training trials).

A second major concern deals with cognitive information strategies during reading as inferred from eye movements. An illustrative question deals with the changes in strategies in reading for detailed vs. general information utilized by "competent" and "less" competent" college level readers. We found, for example, that the shift in strategy discriminates the two levels of reading skill. Competent readers in shifting from general to detailed information abstraction show no change in the size of the "informational chunk" processed but a small (but significant) increase in the amount of time spent on each chunk. Less competent readers, on the other hand, show no change in the time spent on each chunk but reduce the size of the informational chunk taken in when changing to reading for detail. Results such as these will be useful in describing information abstracting stragegies used at different levels of reading skill development and will hopefully lead to new instructional methods which will maximize the development of adequate reading skills.

EVALUATION

Evaluation deals with the effectiveness of the procedure in modifying such aspects of behavior (such as head movements during reading) and utilizes standard statistical techniques. It is too early to attempt to apply our procedures in other than laboratory situations. Thus, no field evaluation is currently being contemplated.

MATERIALS

No specific teaching materials are developed.

PROBLEMS

In research of this nature, instrumentation problems are legion.

February, 1977

Engineering
Public Administration

PROJECT NUMBER: SED 71-0442 A05 **AMOUNT AWARDED:** $ 128,985.

DATE AWARDED: October 7, 1971 **DURATION:** 93 months

PROJECT TITLE: DEVELOPMENT OF A COOPERATIVE GRADUATE PROGRAM IN ENGINEERING AND PUBLIC ADMINISTRATION.

PROJECT DIRECTOR: Joachim I. Weindling

PROJECT ADDRESS: Polytechnic Institute of New York
333 Jay Street, Brooklyn, N.Y. 11201
Phone: (212) 643-4104

PURPOSE:

The purpose of this project is to provide professional education for persons who will be required to make public policy decision regarding matters involving a high technical and scientific content, and those persons required to advise policy-makers in such situations. In the past, and almost as completely today, the decision maker in public policy was likely to have had education in public administration, or less frequently, in engineering or science. With many important public policy issues being closely involved with the application or the control of technology, a "two-world" dichotomy has developed in the field of public administration: the person trained in public administration does not have the technical background to include the effects and limitations of technology in his decisions, while the person trained in technology does not have a full appreciation of the complexity of public administration processes, politics, and economics in a democratic society. While some of the requisite cross-field knowledge is gained in the job, the learning process is unnecessarily painful. Furthermore, it is felt that only a shallow knowledge could be gained by having the engineer take one or a few courses in public administration, or having the public administration graduate take some survey courses in "technology". The answer is graduate level training in both public administration and engineering. Thus was conceived the joint program leading simultaneously to the Master of Public Administration and Master of Science in a specific branch of engineering or science, in which the student has adequate undergraduate preparation.

A two-year program of study, which simultaneously satisfies the residence requirements of the Polytechnic for the MS and of the New York University Graduate School of Public Administration for the MPA has been developed jointly by the faculties of the two schools. The sixty credits required for both degrees is a considerable saving of time over the individual requirements for the two degrees. Study is approximately equally divided between the two schools, with the students registering at the Polytechnic for the first year, and at the NYU/GPA the second. They may however, take courses simultaneously at both schools. Besides regular courses, they attend relevant seminars by faculty and outside specialists, and the capstone is a project supervised by a committee consisting of faculty members from both schools.

AUDIENCE:

The program is intended for persons who will make careers in public administration, in positions where decisions will be made regarding areas having a high level of technical content, and also for staff persons who will be advising these people. Since every level of government, from small muncipalities to the federal government, has such positions, the group is very large indedd. Furthermore, such training would also be of benefit for certain employees of private concerns, who may have dealings with public officials in these areas -- some obvious examples of such concerns would be utilities, oil companies, and builders.

INNOVATION:

We believe that the cooperation between a school of engineering and a school of public administration to provide substantial graduate level education in both fields is unique. By careful integration of requirements of the two Masters degrees a saving of 20 credits is realized over the work required to serve the two degrees individually. Furthermore, we believe the joint supervision of a project as a requirement is unique, although it has undoubtedly occured on an ad hoc basis in the past.

EVALUATION:

A critical self-evaluation by all personnel involved in the project is planned, to include the director, deans of the two schools involved, participating faculty and participating students and graduates. Since some of the former students have now gone on to take professional positions their conclusions regarding the usefulness of the program should be extremely relevant, and will become more so as time goes by: furthermore, their supervisors will be asked to rate the program as well as the graduate. Journal articles will be prepared for both an engineering journal and a public administration journal to aid in disseminating knowledge gained in the establishment and operation of the program. This information will then be submitted to a variety of public administrators for critical evaluation.

MATERIALS:

The first document prepared for the project is a joint program of studies detailing the requirements for MPA and for the Master of Science in each of the engineering and scientific branches. A complete revision of these requirements was necessitated by changes in the degree requirements at both NYU/GPA and the Polytechnic, the latter due to the merger with the NYU School of Engineering. The revised brochure describing the program and requirements is available gratis from the director.

A series of case studies is to be prepared as part of the project. The first of these is entitled "The Effect of National Spending Practices on Engineering Employment". The study involves both analysis and simulation modeling, and has attracted considerable interest; it is available from the Project Director at cost, $7.50. Some work has been done on the study of "Policy Implications of Residential Energy Consumption". The next study will most likely deal with alternate policy decisions relating to Mitchell-Lama Housing in New York City

PROBLEMS:

A number of unforeseen problems have beset this project and have prevented its development on the time schedule originally set. The most drastic occurred when the New York State Education Department mandated a merger of the Polytechnic and the New York University School of Engineering Sciences(SES). This grant had originally involved the joint program between the NYU/GPA and SES schools, and the intra-university arrangements were relatively simple. With the uncertainty that preceded the merger, recruiting for the program was halted. After the merger, the grant was transferred to the merged institute, Polytechnic Institute of New York. The two schools involved were now no longer part of the same institution, and cooperation in administrative and financial matters became much more complicated; however, this new relationship perhaps brought a more relevant model for other programs of this type. Actually, the geographical distance between the cooperating institutions is now much less than it was when two NYU schools were involved; nevertheless, meaningful interaction between the two faculties remain a serious problem.

Another difficulty that has seriously impaired the program development has been two turn-overs in project directors. The first director left the Polytechnic for the University of Wisconsin in the Summer of 1974, and his replacement was forced by pressure of faculty elective office to relinquish the directorship in the Summer of 1975. Thus a great deal of momentum was lost which it is expected will be regained through the endeavors of the present project director.

February,1977

Chemistry
Mathematics
Physics

PROJECT NUMBER: SED 74-14691 AMOUNT AWARDED: $141,214

DATE AWARDED: May 15, 1974 DURATION: 36 months

PROJECT TITLE: COMPUTER-BASED INTERDISCIPLINARY SELF-INSTRUCTIONAL MODULES

PROJECT DIRECTOR: Harold Weinstock

PROJECT ADDRESS: Physics Department
Illinois Institute of Technology
Chicago, IL 60616
Phone: (312) 567-3387

PURPOSE:

The project's goal is to produce a sequence of self-contained, machine-independent, computer-oriented Student Study Manuals at the introductory college level in chemistry, mathematics and physics. These are to feature discussion sections which involve the student actively in the discovery of phenomena and principles through a series of interspersed exercises, of which many require computer access. Each Manual is to be complemented by a Teacher's Guide which discusses the pedagogic strategy of the various computer exercises, presents the program listings needed in simple BASIC (and often FORTRAN), and lists the solutions for all exercises and problems in the Student Manual. Also to be developed is a series of integrated cross-referenced curriculum guides which suggest a framework for inclusion of the computer-oriented materials into various levels of introductory courses. The overall project is designed to overcome the lack of a proper medium and of necessary documentation for effective computer usage in most college environments.

AUDIENCE:

The materials being developed are for use at the introductory college level by both students and instructors who have minimal computer expertise, and whose campuses provide limited computer facilities and access. While this description fits most college environments, the materials are applicable to any college, and in some instances are suitable at the high school level. It is expected also that liberal use of the materials in the early stages of science education, will lead to greater computer utilization at later times in a student's career.

INNOVATION:

This project represents one of the first instances in which materials are being generated to combine the benefits of computer interaction in a learning mode with self-paced, independent study. Furthermore, it offers a rapid and relatively effortless opportunity for instructors unsophisticated in computer science, to benefit from computer simulation and graphics.

EVALUATION:

Although the primary goal of the project is to produce written materials which involve computer exercises, formative evaluation, and subsequent revisions are being carried out by the 18 project faculty distributed nationally over 3 disciplines in 17 different colleges. Not only are students in these colleges being exposed to preliminary versions of the modules, i.e., the Student Study Manuals, but this has been augmented in hundreds of other colleges and some high schools. Files on all those receiving the modules are being maintained and both student and faculty evaluation forms will be sent to selected institutions in an attempt to arrive at a summative evaluation.

MATERIALS:

The modules being produced are currently being offered for sale on a cost-return basis, and over 1,000 different individuals or institutions have either purchased some of these or received complimentary copies earlier. From the beginning, however, the ultimate goal has been to offer revised versions of the modular materials to commercial publishers under an open bidding procedure. In the interim, several of the modules have been sent to CONDUIT project headquarters at the University of Iowa for inclusion in its documentation center.

PROBLEMS:

Direct computer program transportability without a single change is rarely possible, occurring only where the identical hardware and software is involved. This delays implementation. To avoid the delay, a complete set of programs is being implemented by a number of the participating faculty at their local institutions. Included are some of the more common operating systems. The goal of uniformity in level of presentation and the need for materials at slightly different levels also presents problems. These are being alleviated by strong editorial efforts and by the inclusion of optional sections in the Student Manuals.

ADDITIONAL COMMENTS:

The ongoing reduction in basic cost for computer hardware seems to be generating an even greater interest in this project, and offers, as well, the opportunity for upgrading the graphic nature of the associated computer output and the complexity of the interactive dialogues.

February, 1977

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Physics, Chemistry
Mechanical Engineering
Technology, Electronic
Engineering Technology

PROJECT NUMBER: SED74-22284 **AMOUNT AWARDED:** $324,200

DATE AWARDED: July 1, 1974 **DURATION:** 36 months

PROJECT TITLE: DEVELOPMENT OF A GENERAL ENGINEERING TECHNICIAN CURRICULUM

PROJECT DIRECTOR: Dr. Lawrence J. Wolf; Assistant Director, Donald R. Mowery

PROJECT ADDRESS:
St. Louis Community College at
Florissant Valley
3400 Pershall Road
St. Louis, Mo. 63135
Phone No. (314) 524-2020

PURPOSE:

The purpose of this project is to design and produce a two-year curriculum to prepare general science and engineering technicians with a strong scientific and technological background who can adjust to changes in industry and can transfer to four-year science and engineering programs to continue their education. The curriculum has been named the Science and Engineering Technician Curriculum.

AUDIENCE:

The curriculum is designed for a general audience but has been found to attract minorities and females to a greater extent than traditional technology curriculums.

INNOVATION:

The Science and Engineering Technician Curriculum is multi-disciplinary involving primarily four areas: physics, chemistry, mechanical engineering technology, and electronic engineering technology. The major skill emphasis is in the area of modern electronic instrumentation.

EVALUATION:

Since the goals of this project are specific, the evaluation has been in the form of progress reports written by the project staff and the Curriculum Coordinators at the twelve cooperating colleges.

MATERIALS:

The Science and Engineering Technician Curriculum is documented in the form of fifteen study guides developed for the courses in the curriculum. These study guides include summary statements of principles with example and student problems using these principles. Also included are statements of laboratory objectives.

PROBLEMS:

One major problem encountered was in the original timetable which called for one year of curriculum development followed by two years of field trials. It was found that in order to begin field trials preliminary steps toward implementation had to begin immediately and curriculum development has continued as feedback was obtained from the field trials.

The other major problem was maintaining the integrity of the curriculum at all of the schools involved in the field trials. This problem was solved by the development of the study guides.

ADDITIONAL COMMENTS:

The intent of this project is to design a curriculum to train technicians to fill positions which do not fall into one of the traditional technologies. These technicians should also have the flexibility to adapt to changes in industry. The curriculum is also intended to appeal to minorities and females who, typically, do not enroll in the traditional technologies.

February 1977

International Relations
I.E., Political Science,
Sociology, Economics,
Geography, Psychology

PROJECT NUMBER: SED 74-16300 AMOUNT AWARDED: $187,100

DATE AWARDED: January, 1972 DURATION: 30 months

PROJECT TITLE: DEVELOPMENT AND DISSEMINATION OF LEARNING PACKAGES IN UNDERGRADUATE INTERNATIONAL STUDIES

PROJECT DIRECTOR: William D. Coplin

PROJECT ADDRESS: International Relations Program
Syracuse University
Syracuse, NY 13210
Telephone: (315) 423-3819

PURPOSE:

The purpose of this project is to develop and disseminate short printed modules ranging between thirty and a hundred pages. The modules or learning packages are drawn from those disciplines dealing with international studies and are designed to involve the student in activities that introduce the content. The project is intended to stimulate a collective effort across institutions of higher education at the development, evaluation, revision and dissemination stages.

AUDIENCE:

The packages are designed primarily for freshpersons and sophomores, although a few may be used by upperclasspersons and graduate students. Given the lack of cohesion in the international studies field, the same packages will be used by different instructors at different educational levels.

INNOVATION:

There are three unique aspects of the project. First, producers and users have come from a number of social science disciplines. Packages have been written and used by political scientists, sociologists, geographers, economists and psychologists. While the majority of packages have been produced by political scientists, the ones more recently produced involve the other disciplines.

Second, a peer-review system for evaluating manuscripts has been developed. The editor of the series sends prospective packages that come in from the field out for scholarly and pedagogical reviews. About forty percent of all manuscripts submitted are ultimately accepted and published. This means that the acceptance of a package represents an observable acknowledgement that the author can produce sound educational material. In the more educationally oriented institutions of higher education, this recognition is almost as important as publication in a highly respected journal.

Third, a cooperative organization of post-secondary institutions have formed the Consortium for International Studies Education under the International Studies Organization. This Consortium maintains a communications network, plans presentations and panels at regional and national conferences and conducts week-long training sessions. This helps in disseminating the packages as well as providing feedback for the revision process and stimulating the development of new packages.

EVALUATION:

Two kinds of evaluation were undertaken. (1) The peer-review evaluation was conducted prior to the printing of the packages in field-testing versions. (2) Data on the field-tested packages was collected from users. A committee of the Consortium used the peer-reviews to make decisions to field-test. Evaluations on the field-test data were to be used by the committee to decide on revisions. However, the project was completed before this could be undertaken.

MATERIALS:

Three types of materials were generated by the project. The first was a series of twenty-two learning packages produced in whole or in part through the project. These packages are available from Learning Resources in International Studies of New York. The second was a series of Occasional Papers published by the Consortium for International Studies Education and available from the central offices at Ohio State University. The third is miscellaneous publications available from the source appearing beside the title.

LP#1	Boulding	INTRODUCTION TO THE GLOBAL SOCIETY: INTERDISCIPLINARY PERSPECTIVES
LP#2	Gamble	THE USES OF THE SEA
LP#3	Banks	CROSS NATIONAL DATA ANALYSIS
LP#4	Coplin	A HANDBOOK FOR LIBRARY RESEARCH IN INTERNATIONAL RELATIONS
LP#5	Feraru	INTERNATIONAL CONFLICT
LP#6	Burgess Harf	METHODS OF UNIVARIATE AND BIVARIATE ANALYSIS
LP#7	Burgess Harf	GLOBAL ANALYSIS: A DATA SCHEME AND DECK FOR UNIVARIATE AND BIVARIATE ANALYSIS
LP#8	Kattenburg	DIPLOMATIC PRACTICES
LP#9	Snow Kaylor	INTRODUCTION TO GAME THEORY
LP#10	Bertsch	POLICY MAKING IN COMMUNIST PARTY STATES
LP#11	Gould	SPATIAL DIFFUSION: THE SPREAD OF IDEAS AND INNOVATIONS IN GEOGRAPHIC SPACE
LP#12	Sloan	INTERNATIONAL INTERACTIONS: EVENTS-DATA ANALYSIS APPLIED TO THE MIDDLE EAST
LP#13	Russell	DEPENDENCE AND INTERDEPENDENCE IN THE INTERNATIONAL SYSTEM: AN INTRODUCTION TO INTERNATIONAL POLITICAL ECONOMY
LP#14	Bremer Cannizzo Kegley	THE SCIENTIFIC STUDY OF WAR
LP#15	Willmer	THE NATIONAL POLITICAL BOUNDARY

LP#16	Brislin Segall	CROSS-CULTURAL RESEARCH: THE ROLE OF CULTURE IN UNDERSTANDING HUMAN BEHAVIOR
LP#17	Feld Coate	THE ROLE OF INTERNATIONAL NONGOVERNMENTAL ORGANIZATIONS IN WORLD POLITICS
LP#18	Ostrom	A COLLECTIVE GOODS APPROACH TO UNDERSTANDING TRANSNATIONAL ACTION
LP#19	Miller Kilpatrick	PRIVATE INTERNATIONAL INVESTMENT
LP#20	Hamblin Miller	INTRODUCTION TO MATHEMATICAL PATTERNS OF CULTURAL DIFFUSION
LP#21	Ongley	INTRODUCTION TO THE PHYSICAL LANDSCAPE: WATERSHEDS AND FLUVIAL SYSTEMS
LP#22	Mingst	THE POLITICAL ECONOMY OF INTERNATIONAL COMMODITY TRADE

OCCASIONAL PAPERS

No. 1	Gillespie	"A Strategy for Improving International Studies Education at the Pre-Collegiate Level"
	Alger	"Inventories of Facts, Theories and Assumptions of Students in International Relations Classes"
No. 2	Jackson	"Simulated International Politics: Classroom Exercises"
No. 3	Lopez Riddle	"Teaching About Multinationals: Some Guidelines for Political Scientists"
	Sloane	"Innovation in International Relations Teaching: A Preliminary Report of the Effort at San Francisco State University"
	Barber	"International Studies Media for the Pre-School Child"
No. 4	Hughes	"Teaching International Studies: Involved Organizations and Available Teaching Aids"
	Singer	"The Graduate Curriculum in World Politics: A Pedagogical Note"
No. 5	Travis Baron Rosenband	"Middle East Simulation"
No. 6	Gamelin Kennedy	"AFASLAPOL: The Game of Politics in a Modernizing World"
	Snow	"Revolutionary Society (REVSOC) Simulation"
No. 7	Beres	"A Learning Package in World Order Studies"
No. 8	Leh	"A Free-Time Simulation"
	Kihl	"Linkages Between Nation States and Inter-Governmental Organizations"
No. 9	Finnegan	"Quantitative Analysis in International and Comparative Politics: A Primer"
No. 10	Rosner	"Ethnic and Political Systems"
No. 11	Swansbrough	"Simulated Inter-American System"
No. 12	Mestenhauser	"Learning Informally With Foreign Students"

MISCELLANEOUS PUBLICATIONS

Coplin & Trout	"A Case History on the Consortium for International Studies Education: The Development and Dissemination of Learning Packages for Undergraduates", Syracuse University, International Relations Program
Coplin	"Designing a Learning Package in International Studies: A Learning Package", Syracuse University, International Relations Program
Cole	"Guide for Typing and Producing a Social Science Learning Package", Syracuse University, International Relations Program
Coplin	"Description and Evaluation of the 1976 Summer Institute for the Consortium for International Studies Education", Syracuse University, International Relations Program
Coplin	"Cooperatives for the Development and Dissemination of Modular Materials in the Social Sciences: A Self-Help Plan for Improving Post-Secondary Social Science Education", International Relations Program
O'Leary	"Evaluating Learning Packages: A Study of the Procedures Developed by the Consortium for International Studies Education, and Suggestions for Modifications", Syracuse University, International Relations Program
Coplin	"Teaching About International Conflict and Violence to College Students: Learning Packages and Selected Audio-Visual Materials", DEA News, American Political Science Assoc.
Coplin	"Interdisciplinary Approaches to Cross-Cultural Social Science Education for Undergraduates", ISA Occasional Paper, 1976

PROBLEMS:

A number of problems have affected our success.

1. We have been undercapitalized so that there is no centralized production, distribution and administrative structure to insure quality control and an aggressive promotion effort.
2. Many would-be package producers are not able to define the scope of their efforts narrowly enough. Even if they are able to do that they frequently cannot write for anyone but their colleagues.
3. Incentives for writing, field-testing and evaluating packages are so weak for most college instructors that the system cannot sustain itself without outside support.
4. Lack of a large enough market renders the commercial distribution of learning packages unfeasible.

February, 1977

PROJECT NUMBER: SED74-20752 **AMOUNT AWARDED:** $38,680

DATE AWARDED: March, 1975 **DURATION:** 24 months

PROJECT TITLE: TELECOMMUNICATIONS LABORATORY

PROJECT DIRECTOR: Svein G. Andresen

PROJECT ADDRESS: University of Colorado, EE Dept.
Boulder, Colorado 80309
303-492-6233

PURPOSE:

The objective of this laboratory program is to provide students in a Masters Degree program in Telecommunications with demonstrations and hands-on experience with a variety of communications methods and equipment, and show the students the direct applications of theory including any modifications and compromises necessary because of operations in the real world. Topics include baseband signals, noise, modulation/demodulation for analog and digital signals, sampling, multiplexing, signalling rates, and channel limitations.

AUDIENCE:

The demonstrations and experiments are intended for students in a Masters Degree program in Telecommunication at the University of Colorado. In addition to our students the laboratory is designed is such a way that it may serve as a model for other schools which are in the process of setting up their own programs. The group at this school usually runs between 30 and 40 students a year.

INNOVATION:

Our Master's program in Telecommunications involves work both in engineering and the social sciences and is designed to include students both with and without engineering backgrounds. The program is not expected to make engineers full-fledged social scientists nor to take people from the sciences and liberal arts and make them full-fledged engineers. However, the program is designed to provide a bridge across the social-technical interface. Thus the innovative features of this laboratory are the selection and design of equipment for self demonstration of the various types of communication schemes in a simple and easy-to-understand way for students lacking a technical background (approximately two-thirds of our applicants fall in this category).

EVALUATION:

No formal evaluation is taking place at this time. However, informal evaluation by members of our faculty involved in the Telecommunication program is taking place and will continue for as long as the laboratory is run. As soon as a laboratory manual is available copies will be distributed to interested universities and hopefully comments will be fothcoming.

MATERIALS

When completed, a laboratory manual for students will be made available. In addition, a list of commercially available equipment and a complete description of all electronic systems constructed for this laboratory will also be offered to interested schools and individuals. (Please see enclosed list of purchased equipment and prototype systems constructed as of this date.)

PROBLEMS:

No major problems have arisen as of this date.

ADDITIONAL COMMENTS:

Due to the poor technical backgrounds of the majority of the students expected in this program, it is very important to design the experiments with this in view. Thus one should minimize the number of interconnections required to be done by the students, design or purchase simple to operate equipment, design simple to set up experiments, and bear in mind that one is trying to teach communication and not electronic circuits or how, fpr example, a modulator works.

February 1977

List of Equipment Purchased and Constructed February 1977

Purchased major equipment:

a) 1 ea. Model 750 (Clarke-Hess) sweept function generator ($475 ea.). For filter testing and general baseband generation.

b) 6 ea. Model 748 (Clarke-Hess) AM/FM function generators. For generation of AM, FM, or PM. Analog or digital modulation. This generator is particularly well suited for this lab and is low in price ($539 ea.).

c) 1 ea. Model 801A (Measurements) standard FM signal generator ($992). For FM receiver characteristics.

d) 1 ea. Model 802A (Measurements) standard FM signal generator ($992). For FM receiver characteristics.

e) 2 ea. Type 3200 (Krohn-Hite) variable electronic filters ($500 ea.). For noise measurements and general purpose use.

f) 4 ea. VHF FM receivers, type Dura scan-4 ($60 ea.).

g) 3 ea. VHF AM receivers, type Regency TMR-1 ($120 ea.).

h) 1 ea. AM/FM broadcast receiver, ($60).

Constructed equipment (one prototype each):

a) Channel with echo. (2 types)

b) Equalizer for channel with echo (transversal filter). (2 types)

c) 2 channel time multiplexer. (2 types)

d) 2 channel time demultiplexer. (2 types)

e) Voltage controlled oscillator.

f) Speech quantizer and pulse code modulator (variable no. of levels from 2 to 256).

g) Frequency discriminator

h) Low-frequency mixer

i) Comparator

j) Sideband filter

k) Envelope detector

l) 4 level pseudorandom code generator

m) Various x-tal oscillators

n) Baseband amplifier for noise measurements

o) Triple power supplies.

Under design and construction:

a) Receiving equipment for the GOES, SMS, and TIROS-N weather satellites.

b) FM stereo multiplexer and demultiplexer.

PROJECT TITLE: SINGLE CONCEPT FILMS ON MATERIALS
SCIENCE AND ENGINEERING

PROJECT DIRECTOR: Herbert A. McKinstry

PROJECT ADDRESS: Materials Research Laboratory
The Pennsylvania State University
University Park, Pennsylvania 16802
Phone No. 814/865-1614

PURPOSE:

The purpose of this project has been to make short, limited concept, instructional films for materials science and engineering at the advanced level of undergraduate education. The films are designed to be used both in the traditional classroom setting by the instructor and in a personalized system of instruction by the student. A supplementary grant was received which will provide for the integration and possible adaptation of related NSF supported movies in the field and the preparation of print modules to use with the films as integrated materials.

AUDIENCE:

The films are intended for undergraduates at the junior or senior level, particularly for those in introductory courses on materials science and geological sciences. A background of introductory college physics and chemistry is assumed. In smaller colleges which do not have courses in materials science, instructors in physics, chemistry, and other engineering disciplines will find the films useful in more advanced courses. Considerable use of the films for continuing education in industry is anticipated.

INNOVATION:

Three separate and distinct producing groups were involved in the production of the films: a university motion picture service; an independent nonprofit producing agency; and a commercial producer. This arrangement was intended to offer NSF a comparison of cost and quality in instructional film production. A report on this aspect of the project was proposed and submitted in August of 1976. Copies are available to interested persons. They may be obtained by writing to the project director or to NSF.

Another feature of the project is the development of a technology and expertise in computer animation for full color film production. The project director and his associates have received a number of invitations to make formal presentations of this aspect of the work.

With the extension of the project, made possible by the supplementary grant reported above, still another innovative aspect is added. We believe this will be the first time that instructional films have been integrated directly with print modules prepared as part of the same overall project.

EVALUATION:

The films have been guided and evaluated at various stages of development by a national advisory committee. Members of the committee include some of the country's leading materials scientists as well as faculty of other disciplines from both small colleges and large universities. The committee has monitored the selection of topics, the preparation of scipts and story boards, and the films themselves at work print and answer print stages. Now that they are released, members of the committee and others are evaluating films in typical teaching-learning situations with their own students. Student evaluation reports are being received and analyzed.

MATERIALS:

The project has made available 12 sound films in 16 mm and Super 8 cassette formats, and 2 silent films in the Super 8 cassette format only. The films are accompanied by brochures containing descriptions of the content, suggestions for use, some technical background materials and bibliographical data. Three general topical areas are represented with a number of films in each area. The general subject areas are Phase Equilibria, Strength and Deformation of Solids, and Electrical Characterization of Materials. As a result of the supplementary grant, there will be 3 print modules written to be used with the films as complete instructional packages. Two modules will be available in Binary and Ternary Phase Diagrams. One module will be written on Strength and Deformation of Solids.

The films are currently available for sale and for rent from Audio Visual Services, The Pennsylvania State University, University Park, PA 16802.

PROBLEMS:

The most serious difficulty encountered arose from the distribution of film-making responsibility among three separate producers not entirely under the administrative control of the P.I. This feature of the project put both script development and film production at some distance from the oversight of the prime contractor and resulted in delays in completion. In one case, serious discontinuity occurred with the result that the prime contractor was obliged to assume additional film production responsibility. However, the data from this experience were exactly the kind of information which NSF sought for its comparative study.

PROJECT NUMBER: SED73-06359 A01 AMOUNT AWARDED: $275,800

DATE AWARDED: June 24, 1974 DURATION: 42 Months

PROJECT TITLE: EDUCATIONAL MODULES FOR MATERIALS SCIENCE AND ENGINEERING (EMMSE)

PROJECT DIRECTOR: Rustum Roy

PROJECT ADDRESS: Materials Research Laboratory
The Pennsylvania State University
University Park, Pennsylvania 16802
Telephone: 814/865-3421

PURPOSE:

The overall purpose of EMMSE is the development of a system of modular instructional material for materials science and engineering which is organized according to a rational taxonomy susceptible to subdivision into permutable units. Within this general scope are several important subsidiary aims:

1. Socializing the MSE community to increase awareness of the potential and enhance the prospects for the use of this new educational technology throughout the interdisciplinary field.
2. Identifying, classifying, reviewing and indexing the existing instructional media, resulting in the EMMSE Media Index which is already widely disseminated.
3. Preparing, reviewing, distributing and evaluating a number of print modules - first prototypes and later regular production modules.
4. Establishing a total distribution spectrum including the elements of promoting, disseminating, utilizing and testing the print modules.

AUDIENCE:

The instructional materials are directed at all science and engineering departments, focusing on materials science and engineering, and the various materials industries for continuing education purposes. The interpenetration of materials science and engineering with many other long-established disciplines (e.g., physics, chemistry, mechanical engineering, etc.) means that EMMSE's audience is very large though less well-defined than some others. Hence, instructional materials are being provided for industrial service courses as well as for MSE college majors. The academic level ranges from "reviews" for research workers through industrial continuing education, advanced MSE undergraduate and graduate curricula, and general technology courses.

INNOVATION:

One of the innovations of this project is the unique development of the Media Index. As far as we know the EMMSE Index is the first comprehensive and topical classification of all kinds of media in a single index for a single discipline. The Media Index has been widely received and is enabling MSE teachers to locate a wide range of materials for use in their instructional activities. Its success is already assured.

Another innovation aspect of EMMSE is the special requirement to develop course materials not only for the major departments but also for related disciplines, as explained above. This should help to bridge the gap between the classical disciplines and the newly emerged MSE as well as to broaden the training of students in the classical disciplines. Here, success will depend on good salesmanship, optimization of the INTERMOD linkage and finally on the quality of the modular materials, themselves.

EVALUATION:

Evaluation of print modules and other media considered for inclusion with the EMMSE system of refereed course material is done by peers. The review system which has been established seeks to provide for authors of educational materials the same kind of quality control and recognition given to authors of research articles. Limited student evaluation is also provided prior to the testing stage. Evaluations are used for revision of the modular material prior to printing for testing purposes. Test results will be made available to users in the later dissemination stage.

Evaluators are selected from a master list of materials scientists and engineers who have volunteered to participate in this phase of the program, as well as from those personally known by active EMMSE personnel (TAT, NAC, etc.).

MATERIALS:

The EMMSE Media Index has been published in an experimental form and distributed widely throughout the MSE community. The second edition will contain selected annotated evaluations of the most important listings.

Approximately 40-50 print modules on a variety of topics at a variety of levels will be completed or in process by the end of the grant period. Printed modules can be obtained from the Project Director.

PROBLEMS:

The most persistent problem has been getting authors to complete their writing responsibilities on schedule. Some problems were experienced with obtaining permission from NSF to release the modules because of the formulation of a new dissemination policy at the National Science Foundation.

ADDITIONAL COMMENTS:

Since there are other disciplinary projects with goals similar to those of EMMSE, it has seemed wise to communicate and interact with them as closely as possible. To this end INTERMOD was formed and was to be directed by another NSF-sponsored project. We have initiated contacts and cooperative efforts toward this end. Our aim is to prevent duplication of effort, to learn from each other's mistakes and successes, and to cross-list and publicize each other's products, wherever applicable.

February 1977

PROJECT NUMBER: SED-75-02213 AMOUNT AWARDED: $66,800

DATE AWARDED: June 15, 1975 DURATION : 30.5 months

PROJECT TITLE: CREATION, TESTING AND DISSEMINATION OF PROBLEM SOLVING INSTRUCTIONAL MATERIAL

PROJECT DIRECTOR: Dr. Richard V. Andree

PROJECT ADDRESS: Department of Mathematics
University of Oklahoma
601 Elm Street - Room 423
Norman, OK 73019 405/325-3410

PURPOSE:

The production of instructional material designed to help teach logical thinking to secondary students by use of codes, ciphers, and cryptarithms. It is anticipated that four or five booklets (3 on ciphers, one on cryptarithms, and possibly one on puzzle problem solving) with related instructor's manuals will result.

AUDIENCE:

The material is being developed for use with grades 9 through 12, but actually is being tested by both younger and older groups as well.

INNOVATION:

It is hoped that the use of material (breaking a cipher and cryptarithms) which is not traditionally thought of as mathematics by secondary students may help "turn on" some who find traditional mathematics distasteful, so that the process of logical thinking (not formal logic) can be discussed and taught. Preliminary experiments suggest moderate success can be anticipated.

EVALUATION:

At first standard tests on logical thinking and on attitude toward mathematics were considered. However, our teacher consultants persuaded the investigator that any such attempt would "turn off" many of the very students we hoped to reach. For this reason systematic pre- and post-testing was abandoned; the reactions and reports of teachers using the material in the experimental trial editions will be used in preparing the final version. As a general policy we feel that "scientific evaluations" of any instructional material should be undertaken only on the final product, and that it should not then be undertaken by the same group that created the material. The evaluations used by authors to revise instructional materials can well be subjective and non-behavioral rather than "scientific" as that term is frequently understood.

MATERIALS:

The instructional materials to be developed will consist of eight or ten booklets of enrichment material. There are four or five student texts (less than 100 pages, 5.5" x 8.5" each) plus the related instructor's manuals. We hope the revised material will be available from the National High School Math Club (Mu Alpha Theta) and/or the National Council of Teachers of Mathematics (NCTM), two non-profit organizations known for their interest in keeping good enrichment materials in print and available at low cost. Mu Alpha Theta has already indicated that if NSF permit them to publish CRYPTARITHMS, they will distribute it free to their approximately 1500 chapters.

PROBLEMS:

Any creative publishing effort is fraught with problems and frustrations. They can be understood only by other authors and editors, who need no descriptions. When NSF gives Mu Alpha Theta formal permission to publish these works for Mu Alpha Theta and NCTM distribution, we can continue with the final revisions.

ADDITIONAL COMMENTS:

Teachers interested in evaluating the materials and/or having their students participate in the preliminary experimental evaluation may obtain trial editions at the prices listed below (order from CRYPTO-PROJECT Room 423, 601 Elm, Norman, OK 73019):

THREE BOOKS ON CIPHERS: Single copies $3.50 including preliminary instructor's manual. Classroom quantities $2 each in sets of ten or more. The authors expect feedback of criticisms and suggestions for improvements.

SECRET CIPHERS (Preliminary Trial Edition). Available now. This cartoon presentation of techniques for solving simple substitution ciphers is designed to interest students who are indifferent to ordinary mathematics. It won't make great mathematicians of them, but will start them using logic and common sense to decipher secret messages.

SOLVING CIPHERS (Preliminary Trial Edition). Ready In March 1977. A more advanced presentation, but still in casual cartoon style. Teaches breaking substitution ciphers both with and without word divisions, using frequency distributions and pattern words. A suitable sequel to Secret Ciphers, or may be used as a first introduction for more mature students.

SOPHISTICATED CIPHERS (Preliminary Trial Edition). Ready in May 1977. This volume assumes some understanding of simple substitution ciphers, as would be gained from either of the above volumes. It presents advanced cipher methods including Playfair, Hill Matrix and modern encipherment machines. The Haglen cryptographer and the Japanese "Purple" machine are discussed. This fascinating presentation shows unexpected applications of modern mathematical methods to a little known science: cryptography, the study of codes, ciphers and secret communication. More advanced than the other two cipher volumes, but still easily understood by teenagers.

TWO BOOKS ON PROBLEM SOLVING: Single copies $4.50 including preliminary instructor's manual. Classroom quantities $2.90 each in sets of ten or more.

CRYPTARITHMS (Preliminary Trial Edition). Available now. You can start with this at any level. It is the most carefully written elementary material available on cryptarithms--puzzles made by substituting letters for digits in an arithmetic statement. Over 200 cryptarithms along with careful descriptions of the logic used in solving them, and for creating one's own cryptarithms; carefully prepared material on generalizing the techniques used and transferring them to the solution of real life problems unrelated to mathematics.

PROBLEM SOLVING (Preliminary Trial Edition). Tentative July 1977. Presented for the average and better high school student interested in solving problems--not just problems in algebra and geometry, but real life social problems as well. The currently developing science of "how experts use common sense to attack problems" is presented in terms secondary students can understand and use, without the usual jargon and technical terms.

A check for $20 will bring all five booklets as published, along with the five instructor's manuals and supplementary instructional materials. Order any or all of the above booklets from CRYPTO-PROJECT, Room 423, 601 Elm, Norman, OK 73019.

February 1977

PROJECT NUMBER: SED 75-16576AD1 AMOUNT AWARDED:$173,860

DATE AWARDED: June 25 ,1975 DURATION: 36 months

PROJECT TITLE: AN ALTERNATIVE IN HIGHER EDUCATION IN THE MATHEMATICAL SCIENCES

PROJECT DIRECTOR: C. V. Aucoin

PROJECT ADDRESS: Department of Mathematical Sciences
Clemson University
Clemson, SC 29631

PURPOSE:

The purpose of this project is to develop, test, and report, over a three year period, a new approach to graduate education in the mathematical sciences. The project at Clemson University and a cooperating project at Washington State University will each give an indication of the transportability for the programs developed at the other institution. The objective of this approach is to produce graduates at the M.S. and Ph.D. levels who are better equipped to satisfy the current and predicted national needs for mathematical sciences.

AUDIENCE:

This project is being developed primarily for colleges and universities which offer advanced degrees in the mathematical sciences. In addition it is anticipated that government agencies and industrial firms; that is, prospective employers of mathematical scientists, will be made aware of and be interested in the project.

INNOVATION:

In order to provide effective education for a larger percentage of graduate students who will terminate with the M.S. degree, a new Master's degree program is to be developed and tested. This degree is designed for the industrially oriented Master's degree students and as a foundation for a broadly trained future Ph.D. student. This degree program features expanded course hour requirements, a new diversity of the mathematical sciences in the curriculum and the inclusion within this curriculum of mathematical models courses and courses which interface several of the mathematical sciences. A significant portion of the project is devoted to an innovative development of the models courses.

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The development and testing of an innovative Ph.D. porgram is also a task of this project. The first two years of this Ph.D. program will closely resemble the proposed M.S. program. The student will specialize during the latter portion of the program. The goal of the proposed program is to provide, at the Ph.D. level, training which is more relevant than traditional Ph.D. programs to contemporary mathematical problems. The program provides training for the industrially as well as the academically oriented student. The more innovative aspect of the program is the experimentation with a plan to combine a student's interest in an outside area (i.e., biology, city and regional planning, environmental systems, etc) with the appropriate areas of mathematical sciences

EVALUATION:

An evaluation meeting at Clemson University and one at Washington State University will be conducted to gather input from appropriate government, industrial and academic spokesmen interested in education for mathematical scientists. Also there is associated with the project at Clemson a team of six consultants-three from academic institutions and three from non-academic institutions. This team will aid in the development and the evaluations of the programs to be developed for this project. In addition, representatives from the Department of Mathematical Sciences at Clemson will discuss the project at various professional meetings and at other colleges and universities. Comments received from these discussions will be included in the evaluation of the project.

MATERIALS:

The material results from this project will include detailed outlines of programs for students in mathematical sciences with specialties in one of the areas of computer science, core mathematics, operations research, or probability and statistics. Also to be included are detailed notes on the models courses developed during the project. These materials, together with the evaluations of the results of this project at Clemson, will be made available to any interested persons or institutions.

February 1977

PROJECT NUMBER: SED75-21832 AMOUNT AWARDED: $40,300

DATE AWARDED: 1 December 1975 DURATION: 18 months

PROJECT TITLE: SURVEY OF UNDERGRADUATE TRAINING IN THE MATHEMATICAL SCIENCES

PROJECT DIRECTOR: Truman A. Botts

PROJECT ADDRESS: Conference Board of the Mathematical Sciences
2100 Pennsylvania Avenue, N.W., #832
Washington, D.C. 20037
Telephone: (202) 293-1170

PURPOSE:

The purpose of this project is to make an in-depth survey, for academic year 1975-76, of education in the mathematical sciences in four-year colleges and universities and in two-year colleges and technical institutes in the United States and to prepare and disseminate a report of this survey. A part of the purpose is to develop trend information based on a comparison of the results of the present survey and those of similar surveys conducted for academic years 1970-71 and 1965-66.

AUDIENCE:

This survey and its report are intended to be useful primarily to members of the U.S. professional mathematical community and especially to those who head and make plans for departments in the mathematical sciences in the nation's universities, four-year colleges and two-year colleges. There are some 2,500 such departments. Industrial and other organizations that employ mathematical scientists may also be expected to benefit directly or indirectly from the project.

INNOVATION:

The survey *methodology* is not essentially innovative, since it is part of its purpose to compare results with those of similarly conducted surveys for academic years 1970-71 and 1965-66. As compared with those earlier surveys, however, the present survey is innovative in that it develops more information regarding the age, sex and ethnic group of college and university faculty in the mathematical sciences. Like the previous surveys, the present survey is also concerned with innovation in that it gives some information on the extent and character of innovative mathematical instruction techniques in use in colleges and universities.

EVALUATION:

This project is not being formally evaluated, apart from the fact that its report was examined and passed by a small ad hoc report review committee of the Conference Board of the Mathematical Sciences prior to publication. Some informal evaluation of the usefulness and value of the report will of course be implicit in its reception on the part of its intended audience of professionals in the mathematical sciences.

MATERIALS:

The only material product of the project is its report, entitled *Undergraduate Mathematical Sciences in Universities, Four-Year Colleges, and Two-Year Colleges, 1975-76*. This report is available at $4.00 prepaid from the Conference Board of the Mathematical Sciences, 2100 Pennsylvania Ave., N.W., #832, Washington, D.C. 20037.

PROBLEMS:

The main problem encountered during the project was that of securing an adequate number of responses to the survey questionnaires on the part of departments in the survey samples. This problem appears to have been due (apart from what may be a general increasing resistance to filling out detailed and lengthy questionnaires) to the fact that the survey questionnaires addressed 1975 fall-term enrollments, etc. but could not be sent out until January 1976, owing to delays in the starting date of the project. The main measure adopted to counter this problem was an extensive phone follow-up by the Survey Committee and staff to secure more responses. There was also a check on validity of response data through a small survey of non-respondents.

ADDITIONAL COMMENTS:

The survey results and report have been and are being publicized in a number of ways. The October-November 1976 *Newsletter* of the Conference Board of the Mathematical Sciences carried a two-page preview of highlights from the report prior to its publication in January 1977. Some of the more important and striking results of the survey were described in invited addresses on 31 January 1977 by two of the Survey Committee members, John Jewett and Donald Albers, during the annual meeting of the Mathematical Association of America in St. Louis. In addition, two articles on the survey results are to appear shortly, one of them by Professor Jewett in the *Notices* of the American Mathematical Society and the other by Professor Albers in the *Two Year College Mathematics Journal*.

February 1977

PROJECT NUMBER: SED 75-03520 AMOUNT AWARDED: $176,000

DATE AWARDED: June, 1975 DURATION: 48 months

PROJECT TITLE: MASTER OF SCIENCE DEGREE IN APPLIED MATHEMATICS

PROJECT DIRECTORS: William E. Boyce, Richard C. DiPrima

PROJECT ADDRESS: Department of Mathematical Sciences
Rensselaer Polytechnic Institute
Troy, New York 12181
(518) 270-6384 or (518) 270-6414

PURPOSE:

This new program provides an alternative to the traditional M.S. in Mathematics for those students who wish to prepare themselves for employment in business, industry, or government. It is a "professional" program in the sense that it equips a student to become a practicing applied mathematician in a nonacademic environment.

AUDIENCE:

The intended audience consists of two main groups: (1) Current graduates of undergraduate programs in mathematics, computer science, or in some field to which mathematics can be applied, with an interest in solving contemporary problems, who plan a career using mathematics in industry or government. (2) Individuals now employed in industry or government who wish to improve their mathematical skills. Students may enter the program either on a full-time or a part-time basis.

INNOVATION:

The program emphasizes course work in such areas as mathematical modeling, numerical analysis, computer science, mathematical programming, applied probability, and analytical methods in applied mathematics, rather than the traditional mathematical areas of analysis, algebra, and topology. Each student is also expected to become well-acquainted with at least one potential area of application.

The focal point of the program is a new course on advanced mathematical modeling, embodying a case study approach. During a given year the course consists of several different units, chosen so as to provide a wide variety of problem areas and mathematical methodology.

In some cases instructors are members of the Rensselaer faculty; for other units instructors from industrial or government laboratories are invited to participate. In this way students become aware of the kinds of problems and of the kinds of mathematical methods that are of current interest in industry or government.

EVALUATION:

An Advisory Committee has been formed to monitor the development of the program, and to assist in the formulation of policies concerning it. The Committee consists of well-known applied mathematicians who are currently employed in industrial or government laboratories.

The ultimate evaluation must be based on the success of graduates of the program in securing employment, and their effectiveness as applied mathematicians in their later careers. We are encouraged by the response to date from potential employers; the first students to complete the program will do so during 1977, and there appears to be a considerable demand for their services.

MATERIALS:

No suitable text materials exist for the course on advanced mathematical modeling described above. Thus, notes are being prepared as the course progresses. These are written by the various instructors, with the program coordinator having general responsibility. At an appropriate time this material will be made available in preliminary form to a small number of other colleges and universities. Based on their experience as well as our own, final revisions and modifications will be made. Eventually, a wider distribution of the text is planned, perhaps through a commercial publisher.

PROBLEMS:

In addition to the normal problems involved in organizing, publicizing, and administering a new educational program, the following may be worth mentioning.

Some companies do not encourage their professional employees to participate as lecturers in programs such as this one. Thus, some individuals whom we have approached have been unable to participate, and others have done so only by using vacation time, or making other similar arrangements.

We feel strongly that mathematical modeling can only be learned by trying to do it, rather than by merely watching others do it. Thus, we require each student to complete a Project in Applied Mathematics as part of the degree requirements. We also conduct a seminar in conjunction with the course on Advanced Mathematical Modeling in an effort to provide as much practice as possible for the students in coming to grips with a variety of new and somewhat ill-formulated problems.

February 1977

PROJECT NUMBER: SED62-00019 A12 **AMOUNT AWARDED:** $37185

DATE AWARDED: May 12, 1975 **DURATION:** 15.5 months

PROJECT TITLE: REVISION OF CUPM BASIC LIBRARY LIST

PROJECT DIRECTOR: D. Bushaw

PROJECT ADDRESS: MAA Special Projects Office
Department of Mathematics
California State University
Hayward, CA 94542
(415) 881-3243

PURPOSE:

The first purpose of this project was to produce a revised version of the Basic Library List published in 1965 by the Committee on the Undergraduate Program in Mathematics (CUPM) of the Mathematical Association of America (MAA). Like the original, the list is meant to assist in the selection of mathematics books and other materials for libraries where limitations of budget, opportunities to examine samples, and expertise may make this process difficult. The 1965 List has been very well received, but a revision was needed for three principal reasons: (1) the appearance of many new publications, accompanied by the relative obsolescence of some older items; (2) the rise in importance of a number of areas of mathematics, especially in applications; (3) decided shifts of emphasis in the undergraduate mathematics curriculum.

A second purpose was to establish a system for continually updating the list and for preparing a modified list addressed specifically to the needs of two-year colleges.

AUDIENCE:

The primary audience consists of librarians and mathematics faculty members responsible for selecting library materials, especially in smaller colleges and universities. The list should be useful in other ways to teachers and students of mathematics, e.g. as a guide to independent reading and professional development.

INNOVATION:

The revision lists many new books, and many books under headings representing areas of mathematics that scarcely existed ten years ago. An innovation in procedure was basing the initial survey of newly published items on the "Telegraphic Reviews" section of *The American Mathematical Monthly*, which gives nearly complete coverage and was established only in 1967. The regular contributors to the "Telegraphic Reviews" participated actively in the selection process for the new *Basic Library List*.

EVALUATION:

Every section of the revised *List* was submitted to one or more consultant specialists for criticism. The list as a whole was reviewed and approved before publication by CUPM and by the Committee on Publications of the MAA.

MATERIALS:

The revised *Basic Library List* was published as a paperback in early 1977 and is available at a nominal price from The Mathematical Association of America, 1225 Connecticut Avenue N.W., Washington, DC 20036.

A less tangible product is a new Subcommittee on Basic Library Lists of the MAA Committee on Publications. This Subcommittee, with the assistance of a network of selected monitors reposible for the various sub-areas of mathematics, will generate supplements to the *List*, further revisions, and specialized lists such as the revised two-year college list previously mentioned.

PROBLEMS:

The main problem has been the completely foreseeable difficulty of making a balanced and fair selection of a few hundred worthy books from the many thousands available for consideration. Organization and selection have inevitably involved arbitrary and sometimes painful decisions, but the editorial group trusts that the result will be, if not optimal, at least reasonable and useful.

February, 1977

PROJECT NUMBER: SED72-01123 **AMOUNT AWARDED:** $62,300

DATE AWARDED: December 1, 1973 **DURATION:** 42 months

PROJECT TITLE: SOURCE BOOK IN APPLIED MATHEMATICS

PROJECT DIRECTOR: D. Bushaw

PROJECT ADDRESS: MAA Special Projects Office
Depaftment of Mathematics
California State University
Hayward, CA 94542
(415) 881-3243

PURPOSE:

The prevailing underemphasis on applications in secondary mathematics teaching is due in large part to a lack of convenient sources of problems which are authentic, interesting, and usable in the classroom. Both the underemphasis and the lack of materials have been clearly recognized for years, but the problem persists. The purpose of this project is to develop a source book of applications in the form of problems that are authentic, interesting, and usable in the classroom. The source book will also contain additional material to facilitate the use of the problems.

AUDIENCE:

The source book is addressed primarily to teachers of secondary mathematics (grades 7-12), and through them to their students. It will probably be useful to some two- and four-year college mathematics instructors, and to instructors and students in pre- and inservice training for mathematics teachers. It is hoped that the source book will also be influential on authors of instructional materials for school mathematics.

INNOVATION:

To the best of our knowledge, nothing of this kind has been published in English for about thirty-five years. In that period the high school curriculum has changed greatly and the range of applications has broadened dramatically. The source book itself will be an innovation for the present generation of teachers. It is innovative in at least two particular further respects: it is based in large part on a broad appeal for contributions; and it emphasizes the process of mathematical modeling, which in the past few years has come to be generally recognized as the true interface between mathematics and "the rest of the universe."

EVALUATION:

Besides being evaluated in the usual ways by the sponsoring organizations (the Committee on the Undergraduate Program in Mathematics of the Mathematical Association of America, and the National Council of Teachers of Mathematics) and by NSF staff and their consultants, both the plan of the source book as a whole and most of the individual problems have been evaluated by secondary teachers and other mathematics educators. Although it was originally intended that a preliminary edition should be distributed for evaluation by a larger sample of teachers, the project has evolved in such a way that the editorial group now doubts that the benefits of this procedure would offset the disadvantages of the resulting delay in final publication.

MATERIALS:

The source book will consist of: two introductory essays; a collection of over 550 problems, ranging from simple "story problems" to extended exercises in mathematical modeling, mostly grouped to correspond to standard sections of standard mathematics courses; an answer section; an annotated bibliography; and an index.

It is expected that the source book will exist in essentially final form in the late spring of 1977. The auspices under which it will be published and the manner of distribution are still being discussed.

PROBLEMS:

Early in 1974, in accordance with the original plan, contributions to the source book were solicited by advertisements in a considerable number of periodicals. It was expected that the main function of the editorial group would be to sift through the material received in response and to edit the best contributions for publication. Some fine contributions were received, but in general the respose was smaller than expected and uneven both in quality and coverage. For this reason the editorial group has had to develop large amounts of material from other resources, and this in turn has caused delays in the completion of the project.

ADDITIONAL COMMENTS:

While the sponsors of this project naturally hope and expect that the source book will be useful as a source book, they also hope that it will act as a stimulus to further efforts along the same line by individual teachers, by authors, and by other professional groups. Perhaps it will contribute also in this way to a much desired reorientation of secondary mathematics education, of which a general flourishing of good applied problems will be the principal manifestation and the principal instrument.

February, 1977

PROJECT NUMBER: SED72-07370 **AMOUNT AWARDED:** $65,800

DATE AWARDED: September 1, 1972 **DURATION:** 45 months

PROJECT TITLE: CASE STUDIES AND RESOURCE MATERIALS FOR THE TEACHING OF APPLIED MATHEMATICS AT THE ADVANCED UNDERGRADUATE LEVEL

PROJECT DIRECTOR: D. Bushaw

PROJECT ADDRESS:
MAA Special Projects Office
Department of Mathematics
California State University
Hayward, CA 94542
(415) 881-3243

PURPOSE:

For some years the Committee on the Undergraduate Program in Mathematics (CUPM) of The Mathematical Association (MAA) has been recommending that undergraduate curricula in mathematics should include one or more courses in applied mathematics with emphasis on the process of mathematical modeling. The recommendation has received wide endorsement, but a barrier to its implementation has been a lack of suitable printed materials on which such courses might be based. The need has been for realistic descriptions of applications of mathematics which, as regards both mathematical and non-mathematical content, would be within the reach of advanced undergraduates concentrating in mathematics.

The goal of the present project, sponsored by CUPM, was to meet this need with materials not only drawn from authoritative sources but also tested for teachability in the classroom.

AUDIENCE:

The materials are written for instructors and students in courses of the type just described, and those involved in seminars, special projects, and other educational activities having the same general goal. The primary audience consists of the instructors, who may want to adapt the materials to the specific needs of their students instead of distributing them intact; but the possibility of direct use by students is not excluded. The Case Studies may also appeal to some mathematics instructors and others as general professional reading.

INNOVATION:

As already suggested, the materials constitute an instructional resource of a type difficult to find when the project was begun, and still scarce. Because of the depth and variety of the several Case Studies, they differ from what is found in current textbooks in applied mathematics. Because of the style in which they are done, and in particular because of the intentional limitation of the mathematics to standard undergraduate subjects, they are much more accessible to undergraduate students than the usual articles, reports, and other published accounts of authentic applications of mathematics.

The fact that they have been tested in diverse colleges and universities should enhance both their usefulness and their acceptance.

EVALUATION:

The classroom testing already mentioned has of course included a large component of evaluation. The distribution to mathematics departments is being accompanied by a request for criticism, reports on use, and any other comments. These will be taken into account when later versions are prepared.

MATERIALS:

The materials were published late in 1976 under the title Case Studies in Applied Mathematics. One copy was sent to each of the more than two thousand college and university departments of mathematics in this country. For as long as the supply lasts, single copies will be sent free of charge from the project address upon request.

The volume opens with an introductory chapter, "The Process of Applied Mathematics," by the editor, Maynard D. Thompson. This is followed by a report "The Trial Teaching of the Modules" and then the following case studies: "Measuring Power in Weighted Voting Systems," by William F. Lucas; "A Model for Municipal Street Sweeping Operations," by Alan C. Tucker and L. Bodin; "A Mathematical Model of Renewable Resource Conservation," by Colin C. Clark; "Some Examples of Mathematical Models for the Dynamics of Several-Species Ecosystems," by H. R. van der Vaart; "Population Mathematics," by Frank C. Hoppensteadt; "MacDonald's Work on Helminth Infections," by Donald Ludwig and Benjamin D. Haytock; "Modeling Linear Systems by Frequency Response Methods," by William F. Powers; "Network Analysis of Steam Generator Flow," by Thomas

A. Porsching; and "Heat Transfer in Frozen Soil," by Gunter Meyer.

PROBLEMS:

No noteworthy problems have been encountered in the execution of this project.

February, 1977

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PROJECT NUMBER: SED75-17322 **AMOUNT AWARDED:** $204895

DATE AWARDED: June 15, 1975 **DURATION:** 47.5 months

PROJECT TITLE: SERVICE-ORIENTED OPTIONS IN MATHEMATICS

PROJECT DIRECTOR: D. Bushaw

PROJECT ADDRESS: Department of Pure and Applied
Mathematics
Washington State University
Pullman, WA 99164
(509) 335-8518

PURPOSE:

The primary purpose is to develop new educational options, primarily at the graduate level, to prepare for non-teaching careers in the mathematical sciences. Special emphasis will be placed on skills required for effective communication and collaboration with non-mathematicians. Underdevelopment of these skills is widely regarded as a major barrier to best use of mathematical talents in management, industry, government, and other nonacademic settings.

AUDIENCE:

Although the immediate audience will consist of graduate students at Washington State University, the ultimate audience will be departments in the mathematical sciences at other educational instutions, where some of the results of this project may be found adaptable to local conditions and thus contribute to widespread improvements in graduate mathematics education.

INNOVATION:

Specific features of the new options will include: (1) new curricula with strong interdisciplinary emphases, developed in consultation with nonacademic mathematicians and employers of mathematicians as well as university personnel outside mathematics; (2) course outlines and other instructional materials for courses and seminars stressing mathematical modeling of real-world phenomena; (3) on-campus and off-campus work experiences (internships and "preinternships") involving significant interaction with specialists in other fields; (4) theses combining mathematical research with immediate application to problems of current interest originating outside mathematics. In all of these respects the project is being aided by a succession of visiting staff members selected for what they can contribute to the program on the basis of their own experiences.

EVALUATION:

All major aspects of the project will be evaluated by a twelve-member national advisory committee. The project will also be closely coordinated with the project "An Alternative in Higher Education in the Mathematical Sciences" at Clemson University; each of the two projects involves a review of the ideas and materials developed by the other, and there is an exchange of faculty personnel between the two institutions.

MATERIALS:

The project is producing a variety of instructional materials, as mentioned above. The project as a whole will be described in several interim reports and in a final report to be prepared and widely distributed late in 1978.

PROBLEMS:

Because this project requires significant interaction between pure and applied mathematicians, nonmathematicians, academic personnel and nonacademic personnel, it was anticipated that there would be massive problems of persuasion, coordination, and establishment of rapport. These problems have not arisen; we have been given excellent cooperation and support, and there appears to be wide agreement with our objectives.

ADDITIONAL COMMENTS:

A major concern throughout this project is that its results should be adaptable to other institutional settings. For this reason among others, we will be glad to send detailed information about the project as it develops and will welcome any opportunity to exchange ideas about this project or similar ones under way elsewhere.

February, 1977

PROJECT NUMBER: SED76-21804 **AMOUNT AWARDED:** $9,300*

DATE AWARDED: May 15, 1976 **DURATION:** 3½ months

PROJECT TITLE: CONFERENCE ON RESEARCH AND DEVELOPMENT NEEDS ON THE POSSIBLE USE OF HAND-HELD CALCULATORS IN MATHEMATICS INSTRUCTION

PROJECT DIRECTOR: Dr. Edward Esty

PROJECT ADDRESS: National Institute of Education
1200 19th St. N.W.
Washington D.C. 20208 (202) 254-5766

PURPOSE:

(1) Analyze current situation with respect to hand-held calculators as they relate to school mathematics; (2) identify needed research and development on calculators in school mathematics; (3) make recommendations with respect to part (2), above.

AUDIENCE:

Primary audience is policy-makers at NSF and NIE, but it is hoped that the conference proceedings will be of interest and value to anyone concerned with the learning and teaching of mathematics at the pre-college level.

INNOVATION:

This is the first conference on the subject to be sponsored by NIE and NSF. The participants included mathematics educators, mathematicians, psychologists, teachers, and representatives from parents' groups, the textbook industry, and the calculator industry.

EVALUATION:

None, except internal.

MATERIALS:

The conference proceedings will be available from the project director in March, 1977, at no charge for single copies. It will also appear in the ERIC system.

***ADDITIONAL COMMENT:** The National Institute of Education supported the Conference with a matching amount.

February, 1977

PROJECT NUMBER: SED 69-01067 **AMOUNT AWARDED:** $678,200.

DATE AWARDED: 7/1/69-6/30/76 **DURATION:** 84 months

PROJECT TITLE: SECONDARY SCHOOL MATHEMATICS CURRICULUM IMPROVEMENT STUDY (SSMCIS)

PROJECT DIRECTOR: Howard F. Fehr

PROJECT ADDRESS: 165 West 66th Street
New York, N.Y. 10023
(212) 874-3624

PURPOSE:

Traditionally, and still in vogue in the United States of America, secondary school mathematics is taught as four isolated branches-arithmetic, algebra, geometry and analysis. Developments during the 20th Century have shown that all these branches can be taught as one unified mathematics. The purpose of this project was to develop a unified mathematics program for capable students in the secondary schools, grades 7 through 12. By the end of grade 12, the mathematical accomplishment would advance to include one to two years of usual college mathematical study.

AUDIENCE:

The curriculum is designed for the upper 15% of academic ability-those intending to continue their study at the collegiate and university level. In the U.S.A., the potential number of students in grades 7 through 12 is over 1,000,000 students. The number of teachers required to teach these students would number more than 10,000. While intended for the highly capable students, the program can be modified to fit the needs of all college bound students, or 3,000,000 more than those listed above. New York State has embarked on such a program.

INNOVATION:

To create the program, two teams consisting of a mathematician and an educator, using all available knowledge, produced a scope and sequence chart of a proposed curricula. These two charts were transformed into a single one which formed the basis for all subsequent work. Each year, for six years, 20 mathematicians and mathematical educators met in June for two to three weeks to work out the specific content and pedagogy of the course to be taught the following school year. During the months of July and August, about ten writers wrote assigned chapters which were reviewed by other writers and mathematicians, amended and edited. The course was printed and distributed to ten pilot schools.

Each year, 20 teachers were trained in a six week course in the mathematics and pedagogy of the course. These teachers taught ten classes of 30 to 40 students. This procedure was continued for six years. Each course was revised during the following summer, through two revisions. Then the course was released for use in all schools with qualified teachers. During the last four years, institutes were established around the country to inform teachers and educators of the program. An office was maintained to supply information.

EVALUATION:

During each year of the project, each experimental class was observed by a member of the SSMCIS staff. Each visit was followed by a one-hour discussion with the teachers involved. The conclusions were used to amend the course for the following year. All the experimental class teachers convened four times each year at full-day Saturday seminars to evaluate the work of each quarter.

The staff prepared semi-annual tests as well as year-end tests which were administered to all students. Eventually these tests were approved by the New York State Educational Authorities as a proper substitute for Regents Examinations. In Montgomery County, Maryland, eighth grade SSMCIS students were matched with traditional equal ability students on standardized tests with the SSMCIS students showing superior mathematics standing.

In 1972, SSMCIS students were matched against equal ability traditional students in an Educational Testing Service study on Mathematical Competence. The SSMCIS students were superior at the .001 level of confidence.

Similar studies were carried out in the affective domain in 1971 and 1973. The SSMCIS students generally showed a greater understanding of the nature of mathematics. The results of all these evaluation operations were published and distributed and are on file in the SSMCIS files.

MATERIALS:

The SSMCIS curicculum unified the instruction through the basic concepts-sets, relations, mappings (functions) and binary operations,-on which are built the structures-group, ring, field, and vector spaces. Around this central axis the important realizations and activities are developed for both algebra and geometry. The algebra includes the usual number systems and matrices with activities on variables, expressions, functions, equations, inequalities, graphs, problems, etc. The geometry includes lattices, transformations, affine space, coordinates, vectors and euclidean space with such activities as isometries, congruence, dilations, similarities, axiomatics, proof, etc. The geometric and algebraic study merges completely in vector spaces and linear algebra.

The unified organizations permits the teaching of calculus in the 5th and 6th years as well as the study of genuine applications of probability, statistics, computer programming, linear programming, numerical analysis and differential equations.

This material is available in six courses, one for each year grades 7 through 12. Each course is accompanied by a Teacher's Commentary. An added volume for Course 6 contains 5 treatises on modern aspects of mathematics that can be used by senior students for self-study. These books are available from the Teachers College Press, 1234 Amsterdam Ave., New York, N.Y. 10027. The first three courses are available in Japanese from Shin-Su Sha Co. Ltd., 12, 1-chome, Ichigaya-Kagacho, Shinju-ku, Tokyo 162, Japan. A commercialized version is published in the Innovated Section of Addison Wesley Publishing Co. Hebrew translations are available in Israel and an Arabic translation is under way.

PROBLEMS:

The principal problem encountered in innovating the program was the lack of adequately trained teachers-both in knowledge of mathematics and teaching for rational understanding. Where institutes have been held, this difficulty has been overcome and the new courses are succeeding.

February 1977

PROJECT NUMBER: SED74-13047 A05 **AMOUNT AWARDED:** $828,016

DATE AWARDED: 28 March, 1974 **DURATION:** 41 months

PROJECT TITLE: THE MATHEMATICS RESOURCE PROJECT

PROJECT DIRECTOR: Dr. Alan R. Hoffer

PROJECT ADDRESS: Department of Mathematics
University of Oregon
Eugene, OR 97403
Phone No. (503) 686-4726, 686-4705

PURPOSE:

Many teachers at the middle school level (grades 5-8) are lacking in their knowledge of mathematics, didactis and available resources to provide effective learning experiences for their students. With the demands from students, parents, curriculum specialists, administrators, learning theorists and publishers, teachers often do not have time to identify resources that enable them to improve their knowledge of mathematics, learning theories and teaching strategies, nor to locate and select teaching materials to address the learning problems of their students.

The Mathematics Resource Project is developing five collections of inservice and instructional resource materials from which teachers may select to extend their knowledge and to make the learning environment for students more flexible and effective. These are topical resources intended for middle school and junior high school mathematics teachers.

Each resource contains ideas on mathematical content to provide teachers with a deeper understanding of the topic and possible ways to extend and apply the topic. There are sections on didactics, including information on learning theories and practices; techniques for diagnosing and evaluating; and alternative teaching strategies. These are interwoven with comprehensive sets of classroom materials that develop skills; provide examples of applications and problem solving; give suggestions for student or class projects, starting points, carry-through and follow-up.

The titles of the resources developed by the project are:

A. NUMBER SENSE AND ARITHMETIC SKILLS
B. RATIO, PROPORTION, AND SCALING
C. GEOMETRY AND VISUALIZATION
D. STATISTICS AND INFORMATION ORGANIZATION
E. MATHEMATICS IN SCIENCE AND SOCIETY

AUDIENCE:

The resources are intended primarily for the use by teachers of grades 5-8, however, secondary school mathematics teachers could use materials to supplement their programs. Mathematics supervisors and coordinators as well as college and university personnel could use the resources as a vehicle for inservice and possibly preservice programs for teachers. There is no fixed course of study suggested by the project. Teachers could use the resources to supplement a textbook or existing program. Skillful teachers could use the resources as a core around which they could develop a mathematics program for their students. The resources could also be used as mathematical support materials for people who are interested in comprehensive or interdisciplinary problem-solving curricula.

INNOVATION:

A distinctive feature of the resources is that mathematics and didactics ideas for teachers are combined with classroom materials for students.

The materials for teachers consists of didactical information including, for example, a study of error patterns in arithmetic, mental development in geometry, the mastery of basic skills and problem-solving strategies as well as topics in the affective domain of students and teachers. Background information on mathematics is provided for teachers at the middle school level who want to review or have not learned the mathematics that underlies what they teach. Teacher commentaries show relationships between the didactics and mathematics ideas with actual classroom practices and student behavior. These are coordinated with extensive collections of ready-to-use classroom materials emphasizing skill development, problem solving and applications.

EVALUATION:

The project materials have gone through various phases of formative evaluation for three years. The resources have been used and evaluated by teachers with no prior training in the materials as well as by teachers who participated in workshops using the resources in part or in a complete set.

Currently, four resources are being subjected to a summative evaluation to determine the extent the resources affect teacher behavior in the short run. Teachers in fifty classrooms in Oregon have received different degrees of orientation to the resources ranging from no formal introduction to two-hour introductory workshops in the fall followed by help-sessions and visitations.

The evaluation team consists of five people who have not been associated with the project development. Two of these form the advisory panel of the evaluation and the other three members form the field staff who work with the teacher-users. The evaluation will be completed by June 1977, and a final report by the evaluation team will be submitted to the National Science Foundation.

MATERIALS:

Experimental editions of resources A, B, C, and E have been printed and field tested. Resource D: STATISTICS AND INFORMATION ORGANIZATION will be completed by Summer, 1977.

A request for proposals has just recently been sent to publishers. A final agreement to publish the materials has not yet been made.

PROBLEMS:

There will likely be insufficent time available during the remaining grant period to revise the resources. However, such revision may be carried out by a publisher.

ADDITIONAL COMMENTS:

The project has made no effort to publicize availability of the materials and yet several hundred requests have been received from teachers at all levels and localities who have offered to buy the resources.

Responses from teachers who have field tested the materials have generally been very positive.

February, 1977

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PROJECT NUMBER: SED 74-12264 A02 formerly GZ-3436

AMOUNT AWARDED: $56,030 formerly $46,363

DATE AWARDED: May 21, 1975

DURATION: 9 months

PROJECT TITLE: COLLEGE FACULTY WORKSHOP ON COMPUTER GRAPHICS FOR LEARNING MATHEMATICS

PROJECT DIRECTOR: Roger B. Kirchner

PROJECT ADDRESS:
Carleton College
Northfield, MN 55057
(507) 645-4431, ext. 287

PURPOSE:

The production of 35mm slide sequences and Super 8 films for learning mathematics using the computer graphics facilities of Carleton College. The products are designed to enhance geometrical intuition and reinforce understanding of mathematical concepts and methods through static (slide sequence) and dynamic (film) examples.

INNOVATION:

Computer graphics is a natural tool for the study of mathematical concepts as many have geometrical interpretations. But computer graphics is not widely available, and where available is difficult to introduce into classroom settings. Recorded images on slides and film can be used efficiently in the classroom. The interaction of computer graphics is lost on film, but examples can be viewed which take considerable time and preparation, even with computer graphics. The materials are thus of value even to individuals who have access to computer graphics.

Of equal importance is the fact that the materials were produced by imaginative, dedicated college teachers who had experience working together on using computer graphics to implement mathematical ideas. This experience was gained in an NSF Summer Institute for College Teachers during the summer of 1973. Slides and films were then produced for the benefit of the participants. Units for wide scale distribution were produced in a 1974 NSF College Faculty Workshop. Revision and documentation was completed in the 1975 Workshop.

EVALUATION:

The project is yet to be systematically evaluated. The College Faculty Workshop program did not provide for an evaluation phase.

MATERIALS:

The materials consist of thirty-three black and white Super 8 films (available in Kodak Cartridges or Technicolor Loops), twenty-four slide sequences (in sixteen sets of about 36 slides each), and a packet of plotter drawn graphs from which overhead transparencies can be prepared. Each unit has a one to ten page 8 1/2 x 11 format write-up which describes the purpose of the unit. A forty page booklet summarizes the units verbally and pictorially. A 200 page book contains all the write-ups. The program is known as COMPUTER GRAPHICS FOR LEARNING MATHEMATICS, and is available from Carleton College, Northfield, Minnesota 55057.

PROBLEMS:

The problems were primarily technical. A movie camera was interfaced to the minicomputer which drove the storage scope used for the project. The graphics language was modified to enable the shutter to be tripped under program control. The movies were thus written as computer programs.

Image quality was a problem due to the low light level of the storage scope. The film was developed as a negative (black drawing on white background) in a high contrast developer. This format is accepted by students, and does not seem to detract from learning.

ADDITIONAL COMMENTS:

The Computer Graphics for Learning Mathematics program is now available and should receive some systematic evaluation. This is somewhat difficult as the materials do not constitute a course, but are designed to enrich a variety of existing courses. There should be a way to encourage instructors to use the materials in a creative way and have such uses summarized and made available. Perhaps sets could be made available to selected high schools, junior colleges, four-year colleges, and universities with the expectation that use would be reported. Also, the materials might be critiqued by workshops on instructional materials.

February 1977

PROJECT NUMBER: SED 74-15045 AMOUNT AWARDED: $586,045

DATE AWARDED: April 10, 1974 DURATION: 38 months

PROJECT TITLE: PROBLEM-SOLVING STRATEGIES AND APPLICATIONS OF MATHEMATICS IN THE ELEMENTARY SCHOOL (MATHEMATICAL PROBLEM SOLVING PROJECT)

PROJECT DIRECTOR: John F. LeBlanc

PROJECT ADDRESS: Mathematics Education Development Center
Indiana University
814 E. Third Street
Bloomington, IN 47401
(812) 337-1163

PURPOSE:

The general mission of the project was to improve the problem-solving performance of fourth-, fifth-, and sixth-grade children. Pursuant to that goal, the project proposed to conceptualize a problem-solving model, to develop some instructional materials and techniques consistent with the model, to engage classroom teachers in the development and trial of these materials, to evaluate the effect of these materials on the problem-solving performance of children, and to collect and organize observations and conjectures related to children's problem-solving activities.

AUDIENCE:

While the materials development in this project was aimed primarily at children in grades 4, 5, and 6, other aspects of the project were designed to have an impact on teachers, teacher trainers, curriculum developers, and researchers in mathematics education. The project has produced instructional materials, evaluation instruments, and ideas. The hope is that these will have an impact on the mainstream mathematics curriculum and practices in the schools. In addition, a substantial thrust of the project was toward research related to children's problem solving. The conjectures which have been made by the project will hopefully contribute to the mathematics education research community's growing interest in the area of problem solving.

INNOVATION:

A major innovation of the project has been to introduce "process" problems to elementary school children. These problems are best described by the fact that they can be solved using a variety of heuristic strategies and require only very elementary mathematics. These "process" problems were developed as an integral part of some modules. A module consists of a set of lessons which develop a particular strategy and a set of problems which can be solved using the learned strategy. Classroom teachers worked with project staff to develop these modules.

Children at one site learned to solve the process problems using the project-developed modules. At another site an exploratory probe was made to investigate how children might solve some process problems without the direct instruction provided by the modules. No attempt was made to compare the performance of children using these two different approaches.

Other innovations include: the introduction of the hand calculator in problem solving; an exploratory probe into children's performance in solving more complex real-world or project problems; and an effort to create instruments to measure children's process problem-solving skills.

EVALUATION:

Throughout the life of the project evaluation was an important component. Evaluation efforts included not only the formative evaluation of the classroom materials, but also research activities related to the development of an instrument to measure the process of problem solving in children. Other evaluation efforts encompassed measuring changes in teachers' willingness to teach problem solving and measuring attitudinal changes on the parts of both teachers and children.

Most evaluation activities were conducted by an evaluation team formed from among project staff members. In addition, an external evaluation was funded by NSF in 1975.

MATERIALS:

Instructional modules were developed for three problem-solving strategies, selected because they are easy to use, widely applicable, and appropriate for grades 4-6. These modules are entitled: Using Guesses to Solve Problems, Using Tables to Solve Problems, and Organizing Lists. Each of these modules, designed for about one week of classroom instruction, presents examples of how to apply these strategies and gives a number of problems for the student to solve. Accompanying each module is a deck of problem cards which are color-coded according to difficulty and which include a variety of types of problems from puzzle-type to real-world problems. The modules are not currently available for distribution.

PROBLEMS:

Among the problems encountered was the lack of prior research in children's solving of process problems at the elementary level. This required that much of the early work of the project consist of observations of children. Another problem was the difficulty of communication among three centers, which was caused in part by the distances and the inability of staff to meet frequently. Another problem was that the project at its inception was intentionally broad and not well-defined. Just as the project's goals became better defined, the monies for the project were terminated.

ADDITIONAL COMMENTS:

At the present time the staff of the project is preparing a final report. It is apparent that there is much richness in the concept of teaching process problem solving. Children and teachers alike enjoyed the challenge and were successful with such experiences. It seems evident that long-range research should investigate the optimum way to develop instructional sequences for most effective learning by children. Developmental efforts should be encouraged concurrently with these investigations.

Mathematics
Social Sciences

PROJECT NUMBER: SED72-07371 **AMOUNT AWARDED:** $79,900

DATE AWARDED: June 27, 1972 **DURATION:** 6 years

PROJECT TITLE: PRODUCTION OF SOURCE BOOKS ON APPLICATIONS FOR UNDERGRADUATE MATHEMATICS TO THE SOCIAL SCIENCES

PROJECT DIRECTORS: W. F. Lucas, R. Duncan Luce

PROJECT ADDRESS: MAA Special Projects Office
Department of Mathematics
California State University, Hayward
Hayward, CA 94542
(415) 881-3243

PURPOSE:

Undergraduate curricula and textbooks have not kept up with the increasing use of mathematics in the social sciences. One reason for this is an acute shortage of printed resource materials which are mathematically and scientifically sound as well as pitched at the right pedagogical level. The purpose of this project, which is sponsored jointly by the Committee on the Undergraduate Program in Mathematics (CUPM) of the Mathematical Association of America (MAA) and the Mathematical Social Science Board (MSSB), is to provide some materials of this kind. The materials are based on results of a wide appeal to the mathematical and social science communities, compilations by several specialized panels, and final editing by Professor Samuel Goldberg, Oberlin College.

AUDIENCE:

The materials are addressed to those who teach or write textbooks in undergraduate mathematics as an aid in enriching the undergraduate offering with contemporary applications outside the traditional areas of physical science and technology. They may be used in related ways by social science teachers. They should also provide excellent bases for courses and seminars in mathematical modeling, and especially in this role may be used directly by students.

INNOVATION:

The principal innovations in this project are the kind of material to be produced (see above and below) and the broad range and high qualifications of the persons involved in its development.

EVALUATION:

The materials will be distributed to departments of mathematics throughout the country, and a later collection of reactions and information about how the materials were used is planned.

MATERIALS:

The materials will consist of approximately fifteen units, each concerned with a mathematical topic in one or more of the social sciences. The topics will range over all the social sciences, and each unit will be largely self-contained as regards social science content. The mathematics will be standard undergraduate material (calculus, linear algebra and matrices, probability, and axiomatics). Each unit will contain an introduction to the literature on the topic.

Final publication plans are still being discussed.

PROBLEMS:

Partly because of the diversity of professional viewpoints represented among the contributors, it has been extremely difficult to condense the raw material into usable form. (We take the existence of this difficulty as evidence that the project needed doing.) The difficulty has been resolved by giving the editor a much freer hand than is usual in such cases.

February, 1977

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PROJECT NUMBER: SED71-04449 **AMOUNT AWARDED:** $159,929

DATE AWARDED: September 1, 1971 **DURATION:** 48 months

PROJECT TITLE: DEVELOPING A NEW MATHEMATICS PH.D. OPTION AT THE UNIVERSITY OF MONTANA

PROJECT DIRECTOR: Robert McKelvey

PROJECT ADDRESS:
Mathematics Department
University of Montana
Missoula, Montana 59801
406/243-5311

PURPOSE: To develop a doctoral option adapted to the needs of the "general practitioner" of mathematics, particularly the undergraduate college teacher.

AUDIENCE: Teachers and potential teachers in undergraduate colleges, and individuals who intend to apply mathematics to problems arising in other disciplines and in interdisciplinary work. Most of our graduates so far have taken positions as college teachers, one in an interdisciplinary environmental science program. Another (whose thesis area is mathematical economics) is working as a policy analyst in state government.

INNOVATION: The program emphasizes

1) Breadth of knowledge, across the whole spectrum of mathematics and into neighboring disciplines, and perspective into the historical development of contemporary mathematics;
2) Awareness of the problems of synthesis, interpretation, and communication of mathematical thought, and attention to the skills needed to express mathematical ideas orally and in writing;
3) A sense of vocation as teacher and scholar, functioning as a productive member of the institution and of society;
4) An orientation toward scholarship and continuing self-development throughout the professional career.

EVALUATION:

The program's success will be measured by the ability of our graduates to secure and excel in responsible professional positions. It will also be measured by the degree to which our approach is accepted and adapted by others to their graduate training programs.

On the first point there are some positive indications: Our graduates are quite successful in finding employment in a highly competitive market, and are doing well so far.

On the second there is less tangible evidence: there remain only a handful of quality doctoral programs tailored to the college teacher (e.g. Carnegie Mellon, Oklahoma State). There has been a surge of interest in "interdisciplinary" M.A. and Ph.D. programs in applied math, but there is no evidence that the existence of our program has influenced this development.

MATERIALS: In the way of "software", the program incorporates several new courses and seminars: on modeling, on applications in the sciences, and one which examines the profession of college teacher.

PROBLEMS:

(a) Overcoming initial skepticism within the mathematics department, the university, and the mathematics community nationally.

(b) Recruiting superior candidates at a time when graduate education in mathematics is in severe decline.

(c) Arranging suitable opportunities for participation of our graduate students in interdisciplinary projects - often we seem to have to organize these projects ourselves!

(d) Operating in a period of financial austerity within the university and the scientific community.

ADDITIONAL COMMENTS: None

February 1977

PROJECT NUMBER: SED75-15112 **AMOUNT AWARDED:** $26,060

DATE AWARDED: May 1, 1975 **DURATION:** 31 months

PROJECT TITLE: TOPOLOGY FILMS PROJECT

PROJECT DIRECTOR: Nelson L. Max

PROJECT ADDRESS:
Department of Mathematics and Statistics
Case Western Reserve University
Cleveland, Ohio 44106
(216) 368-2880

PURPOSE:

The original Topology Films Project produced four computer animated color sound films on several concepts in topology, accessible to visual intuition. The purpose of this continuation project is to excerpt the most effective visuals from these 20 minute films into shorter, less expensive films, film loops, and videotapes, and to produce a series of printed units or course modules on related concepts in toplogy.

AUDIENCE:

The films were intended primarily to supplement undergraduate courses in mathematics at the sophomore level and above. However, the curves and surfaces presented can be appreciated for their graphical beauty, independent of their mathematical significance, and have proved interesting to a wider audience.

The first few modules can be used to illustrate concepts of curves, arc length, and parametrizations which might arise in a first course in calculus. The later modules include proofs about limits, and would be more appropriate to a course in basic real analysis, or in topology. These would therefore be directed at the rather limited audience of junior and senior mathematics majors.

INNOVATION:

The films involved new techniques of computer graphics, particularly in the representation of smoothly shaded surfaces, as described in "Computer Animation of the Sphere Eversion", in Computer Graphics, vol. 9 (1975), pp. 32-39. The representation of complex volume filling surfaces moving to their limits exceeded the capacity of the Case Shaded Graphics System hardware, requiring a new method of subdividing the picture into manageable sections.

The modules are in a picture book or film strip format, with a column of pictures, each accompanied by a paragraph or so of text. This highly illustrated format has the goal of increasing visualization and readability.

EVALUATION:

The modules and films are being evaluated by the project director in a topology course in the spring of 1977. They will also be reviewed by the Topology Films Project Steering Committee. The modules will be submitted to the Undergraduate Mathematics and its Applications Project (UMAP) at Education Development Center for peer review and student review. Those selected by UMAP will undergo further classroom testing in the fall of 1977.

MATERIALS:

The four longer films,

1. Space Filling Curves (25 min.)
2. Regular Homotopies in the Plane, I (14 min.)
3. Regular Homotopies in the Plane, II (19 min.)
4. Turning a Sphere Inside Out (22 min.)

are all available for rent or purchase from

International Film Bureau
332 South Michigan Avenue
Chicago, Illinois 60604.

The titles of the modules are

1. Curves and Their Parametrizations
2. The Areas of Images of Curves
3. Limit Points and Limit Curves
4. Completeness and the Dominated Convergence Theorem
5. Nowhere Differentiable Curves
6. Peano's Space Filling Curve
7. Uniform Convergence and Continuity
8. Polya's Space Filling Curve
9. Sierpinski's Space Filling Curve
10. A One-to-One Curve of Positive Area
11. Volume Filling Curves and Surfaces
12. Regular Homotopies in the Plane: Rotation Numbers
13. The Whitney Graustein Theorem
14. Function Spaces, and Subspaces of Codimension One
15. Turning a Sphere Inside Out
16. The Alexander Horned Sphere
17. The Butterfly Catastrophe.

The first nine modules are available in preliminary form from the project director. Testing versions should be available in June, 1977 from

EDC/UMAP
55 Chapel Street
Newton, MA 02160

and revised versions should be available from the same address at the end of 1977.

Short films on the topics of most of these modules will also be available, but a distributor has not yet been selected.

PROBLEMS:

The chief problem in the computer animation for the topics in the new films was the unavailability of competent students familiar with the Case Shaded Graphics System, and willing to program needed additions to the system. In writing the modules, the chief problem was in orienting content of an essentially "definition, theorem, and proof" nature, into a form directed toward the development of specifically stated student competancy goals.

February, 1977

PROJECT NUMBER: SED 74-18106 A04 **AMOUNT AWARDED:** $ 887,200

DATE AWARDED: June 1, 1974 **DURATION:** 32 months

PROJECT TITLE: PROJECT FOR THE MATHEMATICAL DEVELOPMENT OF CHILDREN

PROJECT DIRECTOR: Dr. Eugene D. Nichols

PROJECT ADDRESS:
Mathematics Education
219 Education Building
Florida State University
Tallahassee FL 32306

PURPOSE:

The major purposes of the Project are as follow:

1. To study, by means of individual interviews, the patterns of mathematical thinking of first and second graders. All interviews are video-taped and subsequently thoroughly studied by principal investigators.
2. To develop and test techniques for assessing mathematical understandings and skills of first and second grade children.
3. To study the feasibility of employing different approaches to the teaching of the usual first and second grade level concepts and skills with the aim of achieving greater success.
4. To develop prototype materials in the teaching of the basic mathematical topics.

AUDIENCE:

The findings of the Project are aimed at the following groups:

1. The research findings of clinical interviews are primarily aimed at the mathematics educators and rdsearchers with an interest in the mathematical learnings of young children: these are available in the form of printed publications and videotapes (approximately 1,000 hours) of interviews of individual children. This group is estimated to consist of about 200 people.
2. The test for assessing the prototype teaching materials are intended for use by teachers and supervisors of elementary school mathematics at the first and second grade levels. This group is estimated to be about 300,000.
3. Another group which is benefitting by the Project's products consists of undergraduate elementary education majors in colleges and universities and graduate students of education who are preparing for leadership and research positions at the elementary school level.

INNOVATION:

Although clinical methods were used by others in the past, notably by Piaget, none of the investigations had for its major thrust the research on children's mathematical thinking in relation to the commonly taught skills and concepts. This Project's investigators zeroed in on children's thinking within the context of the everyday mathematical classroom experiences.

EVALUATION:

The Project has been evaluated by three different methods.

1. The Project employed (from the beginning through the end) an internal evaluator who attended all of the meetings of the staff and Advisory Board and also critically evaluated all the pahses of the Project's activities.

2. The NSF employed (for six months) an outside professional evaluator who sat in on all staff and Advisory Board meetings and made on-site findings with the aid of three additional individuals, employed by him for purposes of evaluation. His report is filed with the NSF.

3. A panel representing both professional and laymen was convened in Washington for a week in December, 1975 to evaluate this Project along with others. Alledgedly the results of this evaluation were used by NSF in reaching a decision to terminate the Project. The NSF published the report of the evaluation panel.

MATERIALS:

In addition to those mentioned under the heading AUDIENCE, the following have been developed and are available from the Director.

1. Videotape interviews of children.
2. The Proceedings of the Conference on the Future of Mathematical Education.
3. Technical Reports (10).
4. Newsletters.

Negotiations are presently underway to place all of the produced publications with ERIC for distribution.

PROBLEMS:

The major concern during the duration of the Project was lack of communication with NSF and utter confusion during a period of staff turnover within NSF. As a consequence, the Director couldn't help but feel relieved that the Project had been terminated by NSF and he no longer has to deal with the cumbersome bureaucracy of NSF.

ADDITIONAL COMMENTS:

The Project for the Mathematical Development of Children was an outgrowth of a conference of sixteen outstanding individuals held in Tallahassee, Florida in September of 1973, supported by funds given to the Director by Florida State University. The conference was preceded by writing of papers and reacting to these papers by the conference participants. The major question which was utmost in the minds of the participants concerned the future thrust of mathematical education. After thorough and serious deliberations, it became clear that, before undertaking another major curriculum effort in mathematics the profession must learn more about the nature of children's mathematical thinking and about the ways in which young children learn or fail to learn the basic mathematical concepts and skills. The principal investigators and the Advisory Board members, being senior members of the mathematical and education community, realized the complexity of the undertaking in which so many have failed in the past. The staff at NSF, with whom negotiations were conducted at the time, made an informal commitment to the Project for at least eight years of support. This commitment was a result of the NSF staff's understanding, which they acquired through their attendance at the Tallahassee conference, of the serious nature of the commitment of the senior educators who participated in the conference. With the turnover of staff at NSF this understanding was lost. A simpleminded bureaucratic orientation lead to a decision to terminate the Project after two years of operation, not realizing that a very sound preliminary base had been layed for some anticipated breakthroughs in understanding children's mathematical thinking. It is the hope of the Director that some other agency will recognize the importance of the study of children's mathematical thinking. It must be recognized, however, that funding for such an undertaking must carry a commitment for a long-range support.

February 1977

Mathematics

PROJECT NUMBER: SED75-20145.A01 **AMOUNT AWARDED:** $75,596

DATE AWARDED: 1 July, 1975 **DURATION:** 18 months

PROJECT TITLE: NCTM INSERVICE PROJECT

PROJECT DIRECTOR: ALAN OSBORNE (614-422-4121)
FACULTY OF SCIENCE AND MATHEMATICS EDUCATION
OHIO STATE UNIVERSITY
COLUMBUS, OHIO 43210

PROJECT ADDRESS: NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS
1906 ASSOCIATION DRIVE
RESTON, VIRGINIA 22091 (703-620-9840)

PURPOSE:

The primary goal of the NCTM Inservice Project is the improvement of inservice education for mathematics teachers at the local school system level. During the previous 20 years significant changes in the availability and nature of inservice education have occured. Inservice education has moved from a state of massive federal intervention characterized by the funding of content-oriented institutes sited at institutions of higher education to a state of little, if any, funding provided primarily by the local school system. The teachers' expectations and experiences have changed accordingly. School systems and institutions of higher education have been forced to reconsider the processes, content and funding of inservice education.

The National Council of Teachers of Mathematics knew, on the one hand, that profound shifts in the attitudes and perceptions of mathematics teachers about inservice education has occured. On the other hand, they recognized that there was considerable activity in inservice education that was based upon different structures and processes than were common even ten years ago. The NCTM Inservice Project has collected evidence concerning the changes in inservice education and the effects of these changes as well as described current activities in inservice education.

In particular, the NCTM Inservice Project has:

1. Conducted national surveys of A) elementary teachers, B) secondary school mathematics teachers and C) supervisors of school mathematics to determine attitudes, perceptions and opinions concerning what-is and what-ought-to-be for inservice education in mathematics.

2. Collected descriptions of current inservice programs and

practices for the inservice education of mathematics teachers.

3. Published An Inservice Handbook for Mathematics Education based upon 1. and 2. above. The handbook enunciates processes and principles important in designing and implementing effective inservice education programs.

AUDIENCE:

The Inservice Handbook is useful to individuals responsible for inservice education. The school personnel responsible for the design, funding and implementation of inservice education (i.e. mathematics supervisors, curriculum coordinators, department chairmen, principals, superintendents, et cetera) and the mathematicians and mathematics educators in institutions of higher education who provide inservice programs and courses for teachers should find the handbook useful and informative.

INNOVATION:

The results of the information gathering activities of the NCTM Inservice Project can provide an informed base for the design and implementation of inservice programs for mathematics teachers. Major conclusions of the project suggest:

1. Too much is known about the teaching and learning of mathematics to expect that a preservice teacher education program will be sufficient to meet the needs of teachers throughout their professional life.

2. The single change in the design of inservice programs that would yield the greatest improvement in the performance of teachers and their students is the use of systematic processes that would relate inservice programs and experiences to the school mathematics curriculum and to teachers' needs.

3. Teachers' attitudes and perceptions concerning inservice education are significantly better if they participate in designing and planning the inservice program.

4. Inservice education programs need to be designed that take into account the increased professionalism and academic credentials of teachers. Approximately half of the secondary school mathematics teachers and about 37 percent of the elementary teachers have Masters' degrees. Teachers are earning these second degrees earlier, are staying in the profession longer, and are less likely to interrupt their teaching with a period out of service than was the case even 15 years ago. Thus, post-MA level inservice experiences of a continuing

education nature are a matter of profound need.

5. Institutions of higher education should examine carefully their participation in inservice education. This ranges from simply cleaning up their act in terms of the red tape imposed upon part-time students (teachers) to attempting to relate inservice offerings more closely to the programmatic needs of the schools of the teacher participants.

6. A major difficulty with inservice education, both in the immediate past and currently, is that it follows a wave-like pattern depending on the current fads and political climate for the schools and education. Induced in part by the funding policies and the entrepreneurial sense of inservice educators, the perturbations yield a crisis-like atmosphere for inservice education. This atmosphere severely limits the effectiveness of inservice education in contributing to the solution of the problems of teaching and learning mathematics in the schools. Policies and mechanisms for planning inservice education in terms of the priorities for programmatic needs of the schools should be identified and employed by local school systems, state departments of education and the federal agencies responsible for inservice education.

EVALUATION:

Since materials for the direct use of students or teachers were not produced by the NCTM Inservice Project, no immediate attempts at evaluation were appropriate.

MATERIALS:

The Inservice Handbook is available from the National Council of Teachers of Mathematics in May, 1977 at cost. In addition to chapters reporting the survey results, the handbook has chapters concerned with planning inservice education, implementation, the roles and responsibilities of key personnel in the inservice process, resources, evaluation, higher education, and concludes with a chapter reflecting on the future of inservice education. An appendix contains descriptive abstracts of inservice programs to be found across the United States. The orientation of the handbook is to identify major principles and processes for planning and conducting inservice education rather than identifying the specifics of individual programs the generalizability and applicability of which might be time-bound.

PROBLEMS:

The most serious difficulties arose in getting a good rate of return from the elementary teacher sample for the survey.

ADDITIONAL COMMENTS:

The NCTM Inservice Project is in some senses a needs assessment project identifying strengths and problems concerning inservice education for teachers of mathematics at the elementary and secondary school levels. Thus it is important and appropriate to compare the content of the product of the project, An Inservice Handbook for Mathematics Education, with the results of three needs assessment projects currently being conducted for the National Science Foundation. These projects are:

1. National Survey of Science Education Curriculum Usage.
2. Case Studies in Science Education (CSSE).
3. Review of Literature on Science Education Needs and Practices.

Inservice education should be considered within the context of the totality of problems and issues facing the schools.

February, 1977

PROJECT NUMBER: SED74-18491 **AMOUNT AWARDED:** $72,900

DATE AWARDED: July 1, 1974 **DURATION:** 18 months

PROJECT TITLE: GEORGIA CENTER FOR THE STUDY OF LEARNING AND TEACHING MATHEMATICS

PROJECT DIRECTOR: Leslie P. Steffe

PROJECT ADDRESS: The University of Georgia
Athens, Georgia 30602
404-542-4194

PURPOSE:

The purposes of the GCSLTM are to (1) establish and maintain a consortium of investigators dedicated to the improvement of mathematics education in the elementary and secondary schools through disciplined inquiry, (2) identify fundamental problems and issues within mathematics education (3) conduct studies in mathematics education which contribute significantly to the organization of a particular field of investigation or to the resolution of fundamental problems and issues, (4) promote inter-institutional cooperation which most efficiently utilizes available human resources to address fundamental problems in mathematics education, and (5) translate knowledge in mathematics education into a form useable by school practitioners.

AUDIENCE:

The audience most directly benefiting is the set of active investigators of issues and problems in mathematics education. School practitioners ultimately will benefit through the impact of the products of the investigators.

INNOVATION:

Study groups and participants at conferences devoted to mathematics education have historically called for coordinated efforts in mathematics education devoted to resolution of specific problems or issues. This is one of the first concerted efforts at establishing and maintaining a consortia of investigators in the Colleges and Universities in North America devoted to the study of mathematics education through disciplined inquiry. The consortia of investigators are organized into three project areas (Problem Solving, Teaching Strategies, and Conceptual Development) and further refined into 12 working groups each with a working group leader.

EVALUATION:

There has been no formal evaluation of the GCSLTM by an agency or team of external evaluators. All evaluations have been informal and formative in nature. Continual evaluation by the administration of the GCSLTM has taken place, resulting in major adjustments in working procedures, composition of working groups, and leadership.

MATERIALS:

The research being conducted by the GCSLTM deals with solving mathematical problems; learning and development of rational numbers, ordinal numbers, and cardinal numbers; learning and development of measurement concepts; models for learning mathematics; and a theory of teaching mathematics. The research is broadly based and is intended to extend the knowledge of how children acquire mathematical knowledge and how to effectively teach mathematics.

Substantive products from the funding period include the papers from five research workshops--Teaching Strategies; Number and Measurement; Space and Geometry; Models for Learning Mathematics; and Problem Solving. These reports are available from ERIC/SMEAC at Ohio State University.

PROBLEMS:

Because a consortia of investigators devoted to the study of particular problems and issues is relatively new in mathematics education, various difficulties, both operational and conceptual, have evolved. Among those most salient are the following: (1) graduate programs in mathematics education have placed traditionally heavy emphasis on independence of scholarship. A consortium of investigators have the responsibility of working closely with some harmony. Difficulties arise in the attempt of particular investigators to incorporate problems into their investigations not necessarily of primary interest to them; (2) interinvestigator communication must be maintained over extended periods of time. Difficulties arise in the logistics of holding meetings--especially in the face of dwindling monetary support for University travel. (3) real-time commitments must be obtained from the investigators and must be recognized by the investigators' home institutions as viable professional activity. (4) a vital publication program must be maintained. Difficulties arise in that some investigators are devoting a great deal of energy to editorial tasks rather than research tasks. There is a need for established editors. Moreover, publications of the GCSLTM may not be recognized even though manuscripts are thoroughly refereed.

ADDITIONAL COMMENTS:

A great deal of activity has transpired subsequent to the funding period. During the academic year 1975-76, working group meetings were held at various Universities and professional meetings. During August, 1976, the GCSLTM was represented at the International Congress on Mathematics Education held at Karlsruhe, Germany. Working group meetings continue to be held during the academic year 1976-77. Working papers, technical reports, and monographs are in preparation based on activities completed.

PROJECT NUMBER: SED 75-16157 **AMOUNT AWARDED:** $25,510

DATE AWARDED: 1 March 1975

PROJECT TITLE: ELECTRONIC HAND CALCULATORS: THE IMPLICATIONS FOR PRE-COLLEGE EDUCATION

PROJECT DIRECTOR: Marilyn N. Suydam

PROJECT ADDRESS: The Ohio State University
ERIC Information Analysis Center for Science,
Mathematics, and Environmental Education
1200 Chambers Road
Columbus, Ohio 43212
Phone: 614-422-6717

PURPOSE:

The purposes of the project were to:

(1) Collect information regarding the use or non-use of calculators, and to give the wide range of reasons why educators and others believed that the calculators should or should not be used in schools;

(2) Analyze the arguments reported by those questioned and in the literature, in order to determine the potential impact or lack of impact of the calculator on the curriculum; and

(3) Develop a critical analysis of what has and has not been done with calculators at pre-college levels, what knowledge is or is not available about them, and what implication this has for education at the pre-college level.

AUDIENCE:

The intended audiences were educators and all others interested in the use of calculators for instruction.

MATERIALS:

The Final Report of the project was prepared in February 1976. On the basis of analyses of questionnaires completed by state supervisors of mathematics, selected teacher educators in mathematics, manufacturers and distributors of calculators, selected school personnel, and textbook publishers, the cases for and against the use of calculators in schools were synthesized and described. Recommendations made by educators were summarized, and the implications of widespread use of calculators in schools were presented. Ways in which calculators are currently being used in schools were listed. The availability and sales of calculators were surveyed and presented. Articles and research studies related to the use of both mechanical and electronic calculators were abstracted and summarized, and needed research was identified.

Appendices to the Report include an annotated list of references, copies of questionnaires and summaries of the information obtained from them, and four position papers:

(1) "Teaching Mathematics with the Hand-Held Calculator" by G. Immerzeel, E. Ockenga, and J. Tarr
(2) "Hand-Held Calculators and Potential Redesign of the School Mathematics Curriculum" by H. O. Pollak
(3) "Some Suggestions for Needed Research on the Role of the Hand-Held Electronic Calculator in Relation to School Mathematics Curricula" by J. F. Weaver
(4) "Calculators and School Arithmetic: Some Perspectives" by Z. Usiskin and M. Bell

Major recommendations stated in the report are:

(1) A thorough analysis of the mathematics and other appropriate curricula of elementary and secondary schools should be conducted to determine:
    (a) How calculator use could be optimally integrated with existing curricula.
    (b) How curricula should be revised or redeveloped to incorporate optimal use of calculators.
(2) A careful plan for systematic research should be developed.
(3) Following the above steps, appropriate research related to, and development of, curricula should be initiated.
(4) Experiences for teachers at both inservice and preservice levels should be provided, to aid them in using calculators with students.
(5) Information about research and development efforts must be communicated (with speed and accuracy) to parents and other non-educators, as well as to educators.

These recommendations are based on the assumption, derived from analysis of information secured during the project, that calculators are increasingly being accepted as an instructional tool (by both teachers and parents). Therefore an immediate need exists for sound and substantial research and development efforts.

Eight hundred copies of the body of the report were distributed free of charge while the supply lasted (with NSF support supplemented by ERIC/SMEAC support). Copies of the report may now be obtained from the ERIC Document Reproduction Service (Box 190, Arlington, Virginia 22210). The complete report is ED 127 205; the 50-page body is ED 127 206.

February 1977

PROJECT NUMBER: SED74-18948 **AMOUNT AWARDED:** $144,500

DATE AWARDED: 1974- **DURATION:** 36 months

PROJECT TITLE: FIRST-YEAR ALGEBRA VIA APPLICATIONS DEVELOPMENT PROJECT

PROJECT DIRECTOR: Zalman P. Usiskin

PROJECT ADDRESS:
University of Chicago
5835 S. Kimbark
Chicago, Illinois 60637
312 753-2616 or 753-4167

PURPOSE:

The goal is a one-year algebra course which utilizes applications throughout its development, with some special attention to probability and statistics, and which can be implemented without changing other course offerings a school might have.

AUDIENCE:

The intended audience is the set of students currently enrolled in Algebra 1 or First-year Algebra. The materials are designed for students from approximately the 30th to 85th percentile in ability.

INNOVATION:

Content innovations include strong attention to probability and statistics at this level, including sampling, various statistics, simple probability, distributions, and independence. A large number of applications of standard content are included with almost every lesson.

Approach innovations include the use of applications to motivate the fundamental properties of real number operations, the use of models for operations to provide formal connections between mathematics and the real world.

Methodology innovations include an individualized workbook based upon a mastery learning strategy.

Advantages to the approach are expected in the ability of students to handle certain types of consumer problems, problems in probability and statistics, and problems requiring applying simple algebra. It is hoped that students will gain a better understanding of the relationship of mathematics to the real world and thus have a greater appreciation of the value of mathematics. It is also hoped that more students will go on in mathematics after having taken this course.

EVALUATION:

A nation-wide testing program, involving 80 algebra classes (40 using the project materials, 40 using standard materials) in 20 schools, is being conducted through the 1977-78 school year under the direction of Jane Swafford, Department of Mathematics, Northern Michigan University.

All of the major goals of the project are being evaluated. As a consequence, students are being tested on standard content skills, consumer items, problems covering content contained in the experimental materials, and in a variety of attitudinal dimensions.

In five classes in three other schools, the mastery workbook is being evaluated by both formal and informal means. Seventeen other schools are not part of any formal study but are using the text materials and being asked for informal evaluations and suggestions.

The results of these evaluations will be used to improve the materials. In addition, the studies will provide important data about average students in first-year algebra and about the ways in which an applications-oriented course affects such students.

MATERIALS:

The two-volume paperback first-year algebra text Algebra Through Applications can be purchased from the project office as long as copies last. With orders of class size, teacher's notes, answers to exercises, and a copy of the mastery workbook are available. The project is in the process of seeking a commercial publisher for these materials.

PROBLEMS:

There have been no major problems thus far with the project. A printer delay in the production of the paperback text almost caused catastrophe with the nationwide study, but materials apparently arrived to all schools in time (but not without causing undue stress).

The project could have used a second author on the text materials themselves and a full-time person to be responsible for the mastery workbook. Better materials and less pressure to meet deadlines would have ensued. We have not been able to give schools all of the mastery workbook at the beginning of the year.

ADDITIONAL COMMENTS:

Materials like those developed by this project are sorely needed and the sooner, the better. In some respects, this project itself is an experiment in low-scale funding for a curriculum project. Most past projects have involved many more people and much more funding. The director considers this move by the foundation to have been a wise one and only wishes that the amount of paperwork required of small projects could in some way be less than those of larger projects.

February 1977

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PROJECT NUMBER: SED76-19615 AMOUNT AWARDED: $ 448,580

DATE AWARDED: July 1, 1976 DURATION: 24 months

PROJECT TITLE: MODULES AND MONOGRAPHS IN UNDERGRADUATE MATHEMATICS AND ITS APPLICATIONS PROJECT

PROJECT DIRECTOR: William U. Walton

PROJECT ADDRESS: EDC/UMAP
55 Chapel Street
Newton, MA 02160
(617) 969-7100, ext. 280

PURPOSE:

The growing diversity of students in mathematics courses, their general lack of motivation, the proliferation of courses that attempt to meet their professional needs, and the lack of suitable materials on applications of mathematics, all call for new and innovative materials for educating people in mathematics. The goals of the Modules and Monographs in Undergraduate Mathematics and its Applications Project (UMAP) are to develop the required instructional materials and to create a consortium within the mathematics community which will produce and disseminate the materials.

AUDIENCE:

The materials will be written for undergraduate students in service courses in mathematics, e.g., students in Biological and Social Sciences, Economics, Physical and Environmental Sciences, Technology and Engineering. Mathematics majors would use these materials in a supplemental way.

A second group to benefit from the activities of the consortium will be faculty and professionals in industry who have developed innovative approaches and materials for teaching but who do not have the time and resources to write complete text books. The proposed user/developer organization will provide an outlet for their talents and a source of recognition for their contribution to improved teaching.

INNOVATION:

Materials: Each module and monograph will be self-standing except for explicitly stated prerequisites. This will enable them to be used to supplement standard texts or to be arranged in a partially ordered set from which complete courses may be built.

With respect to the undergraduate curriculum, they will fulfill one of the following criteria: (1) to present new or current applications of mathematics; (2) to present mathematics that is new to the undergraduate curriculum; (3) to present traditional material in an innovative and improved manner; or (4) to present material necessary to build a few completely modularized courses with flexible sequences of topics.

Development Process: A field-based process with active participation of users and audience, sensitive to specific local needs and coordinated by a Resource Center at Education Development Center.

Flexibility: Modular material, in a common format that enables ready transfer from one institution to another and is compatible with modular systems of related professional fields.

Field-Testing: Peer review, student reports and field-testing to ensure high quality and appropriateness.

Information System: Continued assessment of needs, indexes of available modules, a newsletter, and a sampler of latest materials.

Dissemination: A network of users to disseminate and publicize materials. Local reproduction of trial manuscripts to reduce risk and initial cost. Commercial production of tested manuscripts with large demand. Direct distribution of quality units by the consortium for small audiences will enhance the overall impact of the system.

Incentives to Participation: Recognition for publication in a peer-reviewed system. Opportunity to share ideas with reviewers, users and other authors. Awards for outstanding material.

EVALUATION:

An extensive evaluation is being planned. The modules themselves will go through a formative evaluation consisting of peer review, student review and field testing. Revision will take place after each of these steps. The peer review includes a review by a professional in the field of application, as well as by a mathematician and a teacher of undergraduate students.

The instructional circumstances under which the modules are used will vary. Studies will be made of the various practices that evolve, with an attempt being made to find out out in what ways and for what students the use of modules are more effective than traditional materials and practices, and in what ways they are less effective.

Finally the development of a user/producer consortium to develop and disseminate materials will be evaluated as to its cost effectiveness and the degree to which it fulfills a need in the mathematics community for contribution to, and recognition for, improvements to the education of students.

MATERIALS:

The materials to be developed over a five year period will consist of over 500 lesson length units that may be arranged in topical clusters: minicourses or complete courses, and some 40 monographs of 75 to 100 pages that treat more advanced topics in the undergraduate curriculum. These materials will initially be available through the project office to members of the user/developer consortium. Refined versions will later be available more widely from either the project office or through a professional society. It is at present uncertain whether enough individual modules will ever have a large enough potential market to support commercial publication. After the end of the grant the production and dissemination of material through the consortium is expected to continue.

PROBLEMS:

As the project is in its early stages it is difficult to forecast what problems will be encountered. It has been difficult so far to establish priorities for modules to be developed and to get representation from all of the various types of undergraduate institutions. Progress is underway at the present time on both these fronts.

February 1977

PROJECT NUMBER: SED73-10003 **AMOUNT AWARDED:** $ 383,100

DATE AWARDED: June 15, 1973 **DURATION:** 42 months

PROJECT TITLE: DEVELOPMENT AND USE OF MODULAR MATERIALS IN INTUITIVE-BASED AND PROBLEM-BASED CALCULUS (Project CALC)

PROJECT DIRECTOR: William U. Walton

PROJECT ADDRESS: EDC/Project CALC
55 Chapel Street
Newton, MA 02160
(617) 969-7100

PURPOSE:

The growing diversification of students enrolled in beginning calculus has led to concern about how to motivate and meet the needs of these students. Project CALC has developed materials consisting of a core course and a module bank, motivating students through the use of instructional problems documented from magazines and texts in various fields. The course, using graphical and numerical techniques to introduce concepts, makes calculus accessible to a wide range of students. It facilitates the assimilation of these concepts by developing them form student activities, including hands-on laboratory and calculator/computer experiences.

AUDIENCE:

The inital audience has been the growing group of poorly prepared and motivated students who must take a course in calculus for elementary use in another field. However, through the use of supplemental modular materials written at a somewhat higher level, the basic core materials can be expanded to serve most traditional audiences except perhaps for the mathematics major.

INNOVATION:

The materials are modular in format and exist on different levels; therefore, a variety of short courses for different audiences may be built from combinations of modules. This format also makes possible the use of individual modules as supplements to a standard course or as substitute coverage for topics in the standard course. The format also permits the replacement of individual modules in the system by improved modules as they become available.

The production of materials took place through a combined central staff effort and diversified author/users throughout the country. Many of the units are problem-oriented, in that they begin with a statement of a real problem, documented in the literature, which the learner will be able to solve upon completion of the instructional material.

Much of the material is intuition based, the presentation beginning with specific cases and proceeding in an interactive style to the generalizations and their applications. Numerical and graphical procedures are used to give a base on which more analytical tools are built.

A few simple hands-on experiments, that generate problems and provide data, are available.

EVALUATION:

All of the materials have been through one or more stages of a system of formative evaluation that begins with peer and student review and ends with field testing in a variety of classes.

The core materials were evaluated by means of pre- and post-skill and attitude tests. Improvement in class means for students using experimental materials was not significantly different from the improvement in class means for students using traditional materials. The materials seem especially well suited for some students, but not for all students.

MATERIALS:

Eighty-five units are available in 20 topical blocks that range from "Rates of Change of Smooth Functions," to "Exponential Growth and Decay" to "Medical Applications of Calculus". Materials are available at cost (small units are .25 each, the largest topical block of 167 pages is $3.25, minimum order is $5.00) for tryout purposes. Write the project director for complete listing and prices. Negotiations are under way for commercial publication.

PROBLEMS:

The most serious problems occurred in changing the direction of the project from its original limited goals to the final broad ones. The original emphasis was on the development by a small writing staff of a set of instructional materials of limited scope for a well-defined target audience. The final goals emphasized the development and pilot operation of an organization to produce quality modular materials by a diversified group of user/developers. The aim was to reach a much wider audience with a broader range of topics. Aids in resolving this problem were the development of a strong National Steering Committee and the sharing of ideas and procedures with projects developing modular materials in other academic fields.

February 1977

PROJECT NUMBER: SED74-21587 **AMOUNT AWARDED:** $20,700

DATE AWARDED: July 1, 1974 **DURATION:** 20 months

PROJECT TITLE: BASIC RESEARCH ON HOW CHILDREN LEARN MATHEMATICS

PROJECT DIRECTOR: Hassler Whitney

PROJECT ADDRESS: Institute for Advanced Study
Princeton, New Jersey 08540
Phone: (609) 924-4400

PURPOSE:

The project has a twofold purpose, namely, to obtain a more complete understanding of how children learn mathematics, and to develop further and more refined methods of helping them learn. For the first purpose, children are studied intensively in the classroom. For the second, a program is being produced to help teachers in the early grades facilitate more active learning, basic skills and problem solving alike.

AUDIENCE:

The project will lead to papers, both by the Project Director and by the Research Associate, Stanley Erlwanger, for educational professionals in school mathematics. The materials are for teachers, consultants, and other professionals.

INNOVATION:

In studying children's learning of mathematics, the main thrust of the project is the consideration of the child in the environment; his attitudes, manners of thinking and attacking problems, how this relates to his feelings, and so on. The necessity of this general approach for more successful learning is becoming amply clear. In the program, the main innovations are the full attention to the child as a whole while working at mathematics, and the very practical approach with the simplest materials.

EVALUATION:

The project is not yet in a state for formal evaluation. The materials are being used in a number of schools in the St. Louis region, with apparent success.

MATERIALS:

The first volume, "Elementary Mathematics Activities, Part A," is available from the Secretary, School of Mathematics, Institute for Advanced Study. It covers basic mathematics in the first and part of the second grades. It offers considerable help in speeding children's learning with attention to both slow and fast learners. How to carry out problem solving through acting out simple stories, and large sections on games and explorations, are particular features. Later volumes have been started.

PROBLEMS:

The principal problem is finding researchers and writers of the high order required for this work. Other problems are the present day climate, generally opposed to innovation, and the lack of funds for carrying out the project on a larger scale.

ADDITIONAL COMMENTS:

The project is far broader in scope and purpose than most. Research papers, combining the theoretical with the practical, are still in process of being prepared. The research, taking into account types of variables not normally studied in this connection, has to a considerable extent the nature of discovery, and hence is not yet amenable to statistical studies. Similarly, the materials are quite different from most texts and workbooks; it may be some time before enough classrooms are using them to permit formal evaluation.

February 22, 1977

Mathematics
Mathematics Education
Psychology of Mathematics Education
Computer and Information Sciences

PROJECT NUMBER: SED76-80599 **AMOUNT AWARDED:** $271,200

DATE AWARDED: October 1, 1976 **DURATION:** 36 months

PROJECT TITLE: SURVEY OF RECENT EAST EUROPEAN LITERATURE IN SCHOOL AND COLLEGE MATHEMATICS

PROJECT DIRECTOR: Izaak Wirszup

PROJECT ADDRESS: Department of Mathematics
The University of Chicago, Chicago, Illinois 60637
Phones: 312-753-2753, 312-753-2741

PURPOSE:

The SURVEY was established in 1956 in the Department of Mathematics at the University of Chicago to answer an urgent need for information and materials in mathematics and mathematics education from East European sources. Its main objectives have been: (1) to analyze current developments in teaching mathematics and related subjects at all levels in the Soviet Union and other Communist countries, (2) to make accessible these studies and other relevant information to projects for improving mathematics education in the United States and to the mathematical community, and (3) to publish for U.S. educators and students some of the best materials from the these sources.

AUDIENCE:

In fulfilling its objectives the SURVEY has concentrated on (a) the new Soviet school mathematics curriculum and the changing principles underlying the aims and structure of Russian mathematics education, (b) the Soviet programs in extracurricular mathematical activities, (c) the literature prepared by outstanding mathematicians for mathematically talented students, (d) the training and improvement programs for mathematics teachers, and (e) the research conducted over the past 30 years by Soviet psychologists and mathematicians in the psychology and methods of learning and teaching mathematics.

The first three SURVEY programs resulted in 39 books translated and adapted for American high school and college students and their teachers. These books have been widely acclaimed and incorporated in high school and college libraries throughout the country.

Program (e) was conducted as a joint effort by the SURVEY and the School Mathematics Study Group (SMSG) of Stanford University and led to the publication of a 14-volume series of SURVEY translation-adaptations entitled Soviet Studies in the Psychology of Learning and Teaching Mathematics. Volumes in this series are studied in seminars and courses in mathematics education and psychology at many colleges and universities across the United States and in Europe.

The Project's Director, who has been engaged in numerous studies of mathematics education in the Communist countries, has delivered some 100 invited addresses and lectures on these SURVEY studies at national and regional meetings of mathematicians and educators, at NSF Institutes, and in Departments of Mathematics throughout the country.

INNOVATION:

The SURVEY is the only organized project in the nation designed to study foreign mathematics education, and was the very first to publish in English mathematical expositions written by world-renowned Soviet research mathematicians for high school and college students and their teachers. These volumes are intended to introduce the reader to various topics of mathematical thought and to engage him in mathematical activity which fosters independent work. Their publication played a definite and significant role in the development in the United States of original expositions of a similar nature.

This Project also published the first English-language monographs and books on the design of modern school geometry courses based on geometric transformations -- an approach which now is being incorporated increasingly in American geometry texts.

The 14-volume SURVEY-SMSG series, Soviet Studies in the Psychology of Learning and Teaching Mathematics, has assisted in opening up new directions in American mathematics education and has inspired research and doctoral dissertations at a number of universities in the United States. This research is already influencing methods of teaching mathematics here. Of singular value, in this regard, are some recent and revolutionary breakthroughs in the psychology of learning geometry -- in particular, the discovery and specification of thought development levels in geometry -- which the SURVEY brought to the attention of mathematics educators and psychologists for the first time, and which, in turn, have led to novel ideas for the design of a modern and much more efficient school geometry curriculum and the application of new methods in teaching it.

The SURVEY's most recent publication is a highly original monograph, The Psychology of Mathematical Abilities in Schoolchildren by V.A. Krutetskii (The University of Chicago Press, 1976), which presents a theoretical foundation for the study of mathematical abilities based, for the first time, on comprehensive research. It is providing U.S. psychologists and mathematics educators with a great variety of innovative ideas.

Over the years, this Project has accumulated, organized and catalogued a unique library of some 12,000 volumes from Eastern Europe in mathematics, its applications, mathematics education, science, science education, educational psychology, education of the handicapped, and the computer and information sciences. This library is unexcelled in the United States in the areas of special interest to the SURVEY's programs.

EVALUATION:

Since the Project's inception, its Advisory Board, whose members are leading mathematicians and mathematics educators in the U.S., has played a prominent role in determining its directions and policies. Publication programs of national scope were developed in which some of the most prestigious academic presses and commercial publishing houses in the nation participated (including The University of Chicago Press, The M.I.T. Press, and Academic Press). Moreover, the early recognition of SURVEY-developed materials led to most fruitful joint programs between the SURVEY and both Stanford University and The University of Georgia.

No SURVEY grant funds have ever been used to pay for the costs of any of its many publications, which are being used in high-school and college libraries throughout the United States. SURVEY publications have been retranslated in Brazil, Canada (French), Italy and Spain for use in those countries.

MATERIALS:

Published SURVEY translation-adaptations (with the names and addresses of the publishers) include the series Topics in Mathematics (15 books from the Russian "Popular Lectures in Mathematics"): Algorithms and Automatic Computing Machines (Trakhtenbrot), Areas and Logarithms (Markushevich), Computation of Areas of Oriented Figures (Lopshits), Configuration Theorems (Argunov and Skornyakov), Equivalent and Equidecomposable Figures (Boltyanskii), The Fibonacci Numbers (Vorobyov), How to Construct Graphs (Shilov) and Simplest Maxima and Minima Problems (Natanson)(published as one book), Hyperbolic Functions (Shervatov), Induction in Geometry (Golovina and Yaglom), Introduction to the Theory of Games (Venttsel), The Method of Mathematical Induction (Sominskii), Mistakes in Geometric Proofs (Dubnov), Proof in Geometry (Fetisov), Summation of Infinitely Small Quantities (Natanson), and What is Linear Programming? (Barsov); and 6 larger mathematical volumes: Convex Figures and Polyhedra (Lyusternik), Eight Lectures on Mathematical Analysis (Khinchin), Multicolor Problems (Dynkin and Uspenskii), Problems in the Theory of Numbers (Dynkin and Uspenskii), Random Walks (Dynkin and Uspenskii), and Infinite Series (Markushevich) — all by D.C. Heath and Company, 125 Spring St., Lexington, Mass.; 4 mathematical volumes by Pergamon Press, Inc., Maxwell House, Fairview Park, Elmsford, N.Y.: Envelopes (Boltyanskii), Shortest Paths (Lyusternik), Successive Approximation (Vilenkin), and Systems of Linear Equations (Margulis); 2 volumes of Geometric Transformations (Modenov and Parkhomenko) by Academic Press, 11 Fifth Ave., New York, N.Y.; 2 volumes of Challenging Mathematical Problems with Elementary Solutions (Yaglom and Yaglom) by Holden-Day, Inc., 500 Sansome St., San Francisco, Cal.; 3 volumes of a series of translations entitled Library of School Mathematics, by The M.I.T. Press, Cambridge, Mass.: Vol. 1, The Method of Coordinates; Vol. 2, Functions and Graphs; and Vol. 3, Sequences, Combinations , Limits.

Also published are SURVEY translations and adaptations of Geometry (Kutuzov), by the School Mathematics Study Group (Vol. 4 of its Studies in Mathematics); 6 new "Popular Lectures in Mathematics": The Application of Mechanics to Geometry (Kogan), Inversions (Bakel'man), The Monte Carlo Method (Sobol'), Number Systems (Fomin), Pascal's Triangle (Uspenskii), What Is Distance? (Schreider); and The Psychology of Mathematical Abilities in Schoolchildren (Krutetskii) — all by The University of Chicago Press, 5801 Ellis Ave., Chicago, Ill.; and the 14-volume series, Soviet tt Studies in the Psychology of Learning and Teaching Mathematics, available from the National Council of Teachers of Mathematics, 1906 Association Drive, Reston, Virginia 22091. [The 14 titles are: Vol. 1, The Learning of Mathematical Concepts; Vol. 2, The Structure of Mathematical Abilities; Vol. 3, Problem Solving in Arithmetic and Algebra; Vol. 4, Problem Solving in Geometry; Vol. 5, The Development of Spatial Abilities; Vol. 6, Instruction in Problem Solving; Vol. 7, Children's Capacity for Learning Mathematics; Vol. 8, Methods of Teaching Mathematics; Vol. 9, Problem-Solving Processes of Mentally Retarded Children; Vol. 10, Teaching Mathematics to Mentally Retarded Children; Vol. 11, Analysis and Synthesis as Problem-Solving Methods; Vol. 12, Problems of Instruction; Vol. 13, Analyses of Reasoning Processes; Vol. 14, Teaching Arithmetic in the Elementary School.]

All of these publications may be obtained from the listed publishers or distributors.

ADDITIONAL COMMENTS:

The SURVEY's findings concerning Soviet mathematics education indicate remarkable achievements in research in the psychology and methods of learning and teaching mathematics and in curricular reform. This was made possible by the active participation of the foremost Soviet research mathematicians, who have created an exceptional literature in mathematics education. It is also apparent that the Soviets are vigorously applying their outstanding accomplishments in mathematical research and in mathematics education to the closely related areas of the computer sciences. Consequently, the SURVEY has extended its studies and broadened its collection to include Russian publications in the information sciences, cybernetics and other applied mathematical disciplines.

Since July 1, 1976, a program for the "Translation, Adaptation and Publication of Selected Soviet Monographs and Books in the Field of the Application of Computers to Management," supported by a grant from the National Science Foundation, has been conducted in the Department of Mathematics by Izaak Wirszup concurrently with the original SURVEY program.

February, 1977

PROJECT NUMBER: SED75-04821

PROJECT TITLE: SELF-PACED COURSES IN EXTRACTIVE METALLURGY

PROJECT DIRECTOR: L. G. Twidwell

PROJECT ADDRESS:
Montana College of Mineral Science
and Technology
Butte, Montana 59701
(406) 792-8321

PURPOSE:

The purpose of this project is to prepare four two semester-hour courses in extractive metallurgy, to present the courses to students at selected colleges (at least four), and to evaluate student and instructor response to the self-paced, tutorial concept of teaching.

AUDIENCE:

The courses are intended for undergraduates majoring in mineral processing, metallurgy, and material science at the junior and senior level. The courses will also be useful to industrial engineers as refresher material.

INNOVATION:

A task force comprised of academic and industrial participants will work together to design, prepare, test, and evaluate the self-paced concept of teaching as applied to the field of extractive metallurgy. It is a cooperative effort that when completed will have tested the proposal that self-paced instruction in extractive metallurgy is possible. Demonstration of the concept in this specialized field will mean that, with the preparation of other materials, departments of small faculty size will be able to offer an expanded curriculum.

EVALUATION:

Two types of evaluation will be conducted, i.e., evaluations of course content and evaluation of student and instructor response to the use of self-paced materials.

A committee of participants from colleges and industry will review each unit for content. Also selected distinguished specialists will review the course units for appropriate content.

Each unit will be presented to students at selected colleges (at least four). Evaluations of the students response to the self-paced tutorial concept and comprehension level will be conducted. Also instructor response to the use of self-paced materials and to materials prepared by a group of specialists will be determined.

MATERIALS:

Four courses are being prepared. Each course will consist of printed notes and audio-visual aids (mainly cassette tape-35mm slides and video tape cassettes).

The project started in July, 1975. The first course was completed for student presentation in February 1977. Remaining courses will be completed for student use in September, 1977.

PROBLEMS:

The coordination and preparation of courses are well advanced. Some difficulty has been realized in receiving resource materials for tape-slide presentations.

ADDITIONAL COMMENTS:

Cooperation from industry and academic people has been very good. A great deal of interest and help in supplying resource information has been generated. The first course is now being used on a test basis at three colleges.

February 1977

Project Number: SED74-15043 **Amount Awarded:** $141,765.00

Date Awarded: 7-1-74 **Duration:** 36 months

Project Title: INCREASING THE FLOW OF ETHNIC MINORITIES INTO CAREERS IN SCIENCE

Project Director: Dr. Winston C. Doby
Assistant Vice Chancellor-
Academic Services

Assistant Project Director: Vicki Nock Talbert
Coordinator
Extramural Projects
Office of Academic Services

Project Address: UCLA
405 Hilgard Avenue
Murphy Hall 2221
Los Angeles, California 90024
(213) 825-8049

Purpose:

This pre-college science enrichment program is a three-year demonstration project which began in July, 1974. The project is testing the following strategy for increasing the participation of ethnic minorities in scientific careers: establish a three-way interaction between the University of California, Los Angeles, a low-achieving high school* with a predominantly minority enrollment, and a high achieving high school** with both majority and minority students in order to:

1. Develop a student/faculty subculture within the minority high school which encourages and reinforces academic achievment.

2. Provide opportunities for minority students from the lower economic strata to interact with minority and majority students from higher socio-economic and educational

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*A high school is defined as low achieving if the students' median achievement score falls significantly below the State mean on the State-mandated achievement tests in reading, language, and mathematics.

**A high school is defined as high achieving if the students' median achievement score falls significantly above the State mean.

backgrounds in an enriched academic setting at the University featuring science, mathematics, and related disciplines.

3. Provide opportunities for minority and majority high school students to interact with minority and majority University students and faculty and with professional scientists.

4. Provide intensive in-service training and development activities for math and science teachers from both schools.

5. Provide opportunities for teachers from participating schools to work cooperatively with University personnel to strengthen the high school math and science curricula.

6. Provide professional support to high school math and science teachers in the form of graduate teaching interns and research assistants.

7. Provide opportunities for future math and science teachers to work with minority and majority students in the environments of the high schools and the enriched college environment.

Two Los Angeles City high schools, Washington High School and Westchester High School, have been selected to participate in the project.

Washington High School: Located in South Central Los Angeles, Washington High School has an enrollment of 3,600 students, 99% of whom are black. Most of the student body come from the lower socio-economic strata of the City although there is a small number of students whose parents are professionals. Washington High has a drop-out rate of approximately 40%. Of the 1,000+ new freshmen who enter each fall, less than 600 actually graduate from Washington. While the enrollment figure remains relatively constant throughout the year, the school actually has a 30% turnover in its student body. Approximately 250 of the entering 10th grade students are enrolled in a college preparatory program of whom 200 have taken at least one year of algebra in junior high school.

The median I.Q. of Washington High School 12th graders is approximately 83; the median scores of its seniors were approximately 14, 26, 6 and 7, respectively, on State-mandated achievement tests in reading, language, spelling and mathematics*. The State means were approximately 22, 40, 8 and 13, respectively, on the achievement tests.

Westchester High School: Westchester High is located in the Southwest corner of Los Angeles, two miles from the Pacific Ocean. Of its student body of 2,600, approximately 31% are minority, most (22%) of whom are black. The median I.Q. of 12th graders at Westchester is approximately 104; and the median scores of its seniors were approximately 24, 43, 9 and 15, respectively, on the State-mandated achievement tests*. All scores were above the State mean. Approximately 600 of the 900 Westchester sophomores are enrolled in college preparatory courses of whom 350 have had at least one year of algebra in junior high school

The socio-economic status of the student body ranges from lower middle class to upper class with most of the students coming from middle-class families. The transiency rate at Westchester High is quite low; most of the students who enroll in the college-prep program as sophomores usually finish high school at Westchester.

Westchester and Washington are approximately 6 miles apart and 10 and 18 miles from the University, respectively.

Students: Eighty 10th grade students from the entering freshman classes of each school who satisfactorily completed one year of algebra and indicated an interest in majoring in math or science were selected for the project.

Approximately 40 of the 80 students from each high school were randomly assigned to participate in the project. The participant group, therefore, consists of two groups of approximately 40 or 80 students. The remaining two groups of 40 students serve as control groups.

Selection of the students at each school was made by the high school and junior high counselors. The random assignment of participating students and control groups was made by an evaluation consultant during the summer programming of 10th graders.

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*California State Testing Program 1971-72, California State Department of Education, Office of Program Evaluation.

During their sophomore year, all Project students were enrolled in Biology and Geometry. In their junior year, all participants were enrolled in Chemistry and Algebra II. For their senior year, it was the initial intent of the Project to have the participant students enroll in a class of their choice at UCLA. However, due to certain problems encountered at UCLA and the lack of enthusiasm on the part of one high school, Project students were allowed to enroll in classes of their choosing at their respective high schools. At Washington High School, 30 students enrolled in Physics and 23 in Trigonometry/Math Analysis. At Westchester High School, only seven Project students enrolled in Trigonometry/Math Analysis and seven in Physics.

Innovation:

Throughout the first two years, participants were in class sizes of 20 students, and had a teaching assistant in the classroom every day for both the math and science classes. In addition, the teaching assistants were available to provide tutoring in the evenings. The Project teachers were also allowed $600 each year to purchase supplemental teaching aids. The following statements indicate the anticipated outcomes of the project with respect to student cognitive and affective development.

1. As compared to their respective control groups, participants will:

    a. Demonstrate significantly higher math and science achievement as measured by the Preliminary Scholastic Aptitude Test (SAT), the Math part of the Scholastic Aptitude Test (SAT-M), and the Math and Science Achievement Tests of the College Entrance Examination Board (ACH-M, ACH-Sci.).

    b. Demonstrate significantly better study skills and knowledge of study techniques as measured by a study skills inventory.

   c. Demonstrate significantly higher levels of aspiration and interest in pursuing careers in the sciences.

   d. Demonstrate significantly greater knowledge of career opportunities in the sciences and the requirements and procedures for pursuing such careers.

   e. Demonstrate more confidence in their ability to compete successfully in college math and science courses.

2. As compared to the high-achieving control group, the low-achieving participants will demonstrate:

   a. At least the same level of achievement in math and science.

   b. Significantly greater knowledge of career opportunities in the sciences and the requirements and procedures for pursuing such careers.

   c. Higher levels of aspiration and interest in pursuing science careers.

3. As measured by SAT-M, ACH-M, and ACH-Sci, the mean high-school achievement in math and science of the participant group will be significantly greater than the mean achievement level of all freshmen entering UCLA in Fall, 1976.

4. The difference between math and science achievement of high-achieving participants and low-achieving participants will be significantly reduced.

Evaluation:

This project contracted with a community agency in order to obtain an objective evaluation. The Joint Center for Community Studies has evaluated the Project for the past two years. The "Third and Final Report, 1974-1977" will incorporate the third year in the three-year analysis. In addition to a comparative analysis of participants and control students over the three years in regard to the above areas, there will be a re-analysis of data gathered in relation to predictions of students (and their characteristics) and success in attempting math and science courses in high school--what are the characteristics of those students who would have completed three years of math and science whether or not they were project participants? The evaluators will attempt several types of analysis (multivariate, multivariate regression, discriminant and profile classification) to obtain as much information as possible.

Copies of the "Third and Final Report, 1974-77," are available upon request after September, 1977.

February, 1977

PROJECT NUMBER: SED76-20191 AMOUNT AWARDED: $148,689

DATE AWARDED: 1 May 1976 DURATION: 24 months

PROJECT TITLE: A STUDY ON THE USE OF COMPUTERS IN THE DEVELOPMENT OF SCIENCE CAREER AWARENESS IN ELEMENTARY SCHOOL CHILDREN

PROJECT DIRECTOR: Arthur L. Korotkin, Ph.D.

PROJECT ADDRESS: Richard A. Gibboney Associates, Inc.
10605 Concord Street, Suite 203-A
Kensington, Maryland 20795
Phone No. 301/949-4510

PURPOSE:

Gibboney Associates, Inc., in collaboration with the Montgomery County (Maryland) Public School System is developing an evaluation of the Science Career Awareness Training (SCAT) program. SCAT involves the utilization of computer technology to provide elementary school students the opportunity to explore, on an individual basis, selected careers in science and their possible interest in them.

It is intended that the information gained from the interaction with the computer will enrich and enhance any information about these science careers previously obtained through experience or contact; and substitute for such experiences for those children who have little or no knowledge about science, the scientific method, and the broad spectrum of science careers. It is thought that this latter group may well include a disproportionately high number of women and members of minority groups in view of the fact that minorities and women are faced with numerous social and cultural barriers that tend to exclude them from fully exploring many career opportunities.

The study will assess the immediate and sustaining effects of providing unbiased and non-stereotypic science career information, via computer terminals, to elementary students during a critical time of their cognitive development and initial career exploration.

POPULATION:

Since the main focus of this research effort is the development of effective methods for introducing members of minorities and women to the world of science, elementary schools that have a high proportion of minority students were selected for the study. Also, to assess the differences in knowledge and interest in science careers of children of varying ages, the research involves a cross-sectional sample of children at three grade levels (4-5-6). The study population consists of eight schools (four experimental and four control), each having approximately 30 students from each grade level. The total anticipated study sample will be approximately 720 students.

INNOVATIVE FEATURES:

This study has two major innovative features--the computer application and the age of the student. To date no computer-based system has been devised to assist in the process of career information dissemination in the elementary schools, nor has any research been conducted to indicate whether such an approach would have a demonstrated impact.

In general, the research concerning career development and career awareness at the elementary level is sparse. As a result little is known about how a child develops a career interest in the sciences, and what influence school, home, or community has on the direction of his or her educational or career aspirations. It is hoped that this study will provide a clearer picture of how a child develops career awareness in the sciences.

It is anticipated that the computer will offer numerous benefits to the student. It becomes a primary source of information that is always there for all students according to their individual needs and interests. Besides accessibility, the computer offers to all students any part of its stored information without bias or partiality. The computer disseminates information in both an untiring and nondiscriminating fashion. It can respond equally effectively to a career question whether it has been asked once or a thousand times within the course of an hour. Of particular relevance to this study, the data provided by the computer is consistently accurate and unchanged regardless of the race or sex of the child requesting the information. In addition, when used in the "interactive mode" the student becomes an active participant rather than a passive observer.

EVALUATION:

To assess the effectiveness of the Dialogues, individual scores on the measures of the dependent variables (career awareness, attitude toward science, occupational and educational aspirations, and knowledge of science) would be collected through a series of Pretests and Posttests with gain scores serving as the measure of a student's performance.

The study will seek to assess differences in student performance: (a) between students experiencing the science dialogues and those in the control group (SCAT vs. No SCAT); (b) between students in different grade levels (4th graders vs. 5th graders vs. 6th graders) with the results reflective of developmental differences; (c) between the sexes; and (d) between members of the minority groups and the "majority" students.

The evaluation will examine both the short-term (immediate) and longer term (1 year later) effects of the program, and the possible differences between one experience and two experiences with the Program.

MATERIALS:

The Science Career Awareness Training system consists of nine computerized dialogues and simulations, each averaging 30 minutes of student contact time. They are written in Coursewriter II on the Montgomery County School System's IBM 370-158. The dialogues describe:

1) The world of science and science careers in general
2) The work of the Engineer
3) The work of the Chemist
4) The work of the Physicist
5) The work of the Earth Scientist
6) The work of the Biologist
7) The work of the Mathematician
8) The work of the Social Scientist
9) The work of the Health Scientist

The system gives the student through verbal (printed text depicted on the computer's cathode ray terminal), visual (a collection of science related photographs depicting scientists at work), and problem-solving experiences (students solve simulated science problems with the guidance of the computer) information covering each of these professions. Included are (a) each profession's work and job responsibilities; (b) the kinds of people a scientist works with; (c) the places the scientist works; and (d) the type of scientific problems that they might solve as part of their profession.

PROBLEMS:

The first major problem area encountered during the conduct of the study was the almost total absence of appropriate career education materials for elementary school age children. As originally conceived it was proposed that the student's science career awareness experience on the computer would be enhanced and enriched by directing the children to suitable and relevant materials made available in the classroom and Instructional Material Center. An exhaustive review was conducted of the materials currently available and virtually nothing was identified in the area of science career awareness that was at the appropriate level for elementary school children and was free from sex and racial bias. As a result the "off-line" activities portion of the project was abandoned. Instead, extra efforts went into enriching the computer-based dialogues themselves.

The other major problem encountered also involved the scarcity of appropriate materials. In this case another void was encountered in the area of suitable assessment tools dealing with the knowledge of, interest in, and attitudes towards future career choices--particularly in the science career area. The scarcity of material in this area meant that new and original instruments had to be developed in order to attempt to measure changes in science career knowledge, interest, and attitudes.

One unanticipated problem arose during the conduct of the study over which we had no control. Because of the nature of the study, i.e., a concentration on the effectiveness of science career awareness training on women and members of minority groups, the experimental schools were selected on the basis of high minority enrollment. During the summer between the first and second phases of the project a desegregation plan was implemented in Montgomery County, Maryland to achieve better racial balance in the elementary schools. Since we had deliberately chosen schools with high minority enrollments, two of the four experimental schools were affected by the desegregation plan. The two new schools selected for the project were those in which the majority of the previous program participants were assigned. The overall impact of this change will be to reduce the sample size of those children who are participating in the program for the full two-year cycle of the project. It appears, however, that a sufficiently high sample size is being retained so as to make all the data analyses in this area meaningful and valid.

ADDITIONAL COMMENTS:

In reviewing the project to date the one major change which would have enhanced the project would have been to devote significantly more time and effort to the development and refinement of the evaluation instruments. There appears to be little question (from the data, observations, and feedback from the students and teachers) that the SCAT program is in fact having some positive effect in the direction anticipated. There is every indication that the children are learning about science and science careers and are retaining this knowledge. The impact of this knowledge on their overall career decision-making process and development is, however, not clear.

At the beginning of the second year of the project additional time was applied to refining and improving the evaluation instruments. They will be administered both pre- and post- during the second phase and many of the children from the first year will be followed through their second exposure to the SCAT materials. It is anticipated that these revised evaluation instruments will lend additional insights to the effectiveness of the program. In addition, it appears that some unanticipated but most welcome data are also being obtained on the general process of career decision-making at the elementary school level. These additional data are being analyzed and will be presented in the final report along with the data dealing with the major thrust of the program.

February 1977

PROJECT NUMBER: SED 74-18711 AMOUNT AWARDED: $57,750

DATE AWARDED: August 1, 1974 DURATION: 18 months

PROJECT TITLE: ASSESSMENT OF FACTORS WHICH INFLUENCE MINORITY PARTICIPATION IN SCIENCE

PROJECT DIRECTOR: Glenda Partee-Scott

PROJECT ADDRESS: Institute for Services to Education
2001 S Street, N.W.
Washington, D.C. 20009
202/797-3500

PURPOSE:

The purpose of this project is to identify and assess those factors which affect the decision of minority students to pursue careers in science and engineering.

AUDIENCE:

This study was designed to (1) contribute to the body of knowledge on the subject of minority participation in the sciences, and (2) provide secondary and post-secondary administrators, counselors and instructors, and science industries with recommendations for intervention strategies whereby minority students can begin to increase their awareness of career opportunities in the sciences and be channeled into science careers. Recommendations for further research into the vocational needs of minority students as well as the types of motivational supports needed for encouraging minority students to seek nontraditional careers also apply to state-wide educational systems, curriculum planners, and community agencies.

INNOVATION:

The study was based on a three-tiered design composed of (1) minority students at two levels of academic and vocational preparation (high school seniors and college freshmen); (2) high school counselors and science teachers; and (3) science employers. These groups were selected because students tend to attend high school, college and seek employment within the same metropolitan area. The interrelated pattern of the impact of student attitudes, counseling practices and occupational opportunities was sought in developing a more complete picture of the career selection process and the role that counselors, teachers and science employers play in the student's decision to seek a science career.

Another innovative feature of the design of the study was the investigation of the motivation, information and reinforcement given minority students within an integrated school setting, and student response and attitudes to the perceived reinforcement received. The literature on the effects of the integrated setting on the minority students is scanty. This effort represents a contribution to the literature on the subject.

EVALUATION:

The project has been evaluated at various stages of development by an advisory committee composed of persons working and living in the locale where the survey was made. Committee members were college and high school science teachers, counselors and administrators who had worked closely with the community and who were knowledgeable about its specific problems and needs. The members of the advisory committee were cognizant of the potential implications of the study.

MATERIALS:

The primary document developed for the project has been divided into three major parts which are to be published separately under the titles: *Impingements on the Career Choices of Black High School Students Regarding Science and Science-Related Fields*; *Impingements on the Career Choices of Black College Freshmen Regarding Science and Science-Related Fields*; and *Perceptions of Teachers, Counselors, and Employers Related to Factors Which Impinge Upon the Career Choices of Black High School Students and College Freshmen Regarding Science and Science-Related Fields*.

Aside from recommendations derived from the findings and conclusions of the total study, a model of intervention tactics and programs has been developed. The model provides counselors, teachers, science employers, colleges and state agencies with (1) methods of channeling minority students into nontraditional career paths such as those in the sciences and (2) the follow-up activities necessary once the initial link has been made. The model also includes steps for reeducating administrators, counselors and teachers regarding the nontraditional career opportunities available to minorities, as well as steps for redress in respect to the past and present patterns of low interest that minorities tend to have in the sciences.

PROBLEMS:

The primary problems encountered in the study were implicit in the research design of the study. Since the study surveyed minority students in an integrated school setting, fears related to the racial overtones of the study had to be dispelled throughout the administration of the survey. Additionally, the dictates of local administrators had to be followed. Frequently, in order to reach the target group, the questionnaire had to be administered to entire classes composed of both minority and white students.

The counselors and teachers who participated in the interview were often reluctant to discuss their own counseling methods regarding minority students. To allay these fears, questions were often set forth in general terms and could be applied to dealings with all students. Unsolicited comments regarding minority students were given greater weight in the analysis of the findings.

ADDITIONAL COMMENTS:
The ambitious scope of the design of the study in seeking to investigate an overall pattern of factors affecting minority participation in the sciences, was limited by the funding level of the project. Problems and delays encountered in administration of instruments and attempts to ensure the integrity of the data further compounded the efforts of the researchers. Nevertheless, the research supported certain hypotheses regarding the specialized needs of minority students with respect to nontraditional career paths and the supports which are being denied them through the present curriculum/counseling structure.

This research efforts represents only a beginning. Implementation of the recommendation is now needed. Further development of the proposed model in conjunction with school and college officials, and science employers should now be undertaken.

February, 1977

PROJECT NUMBER: SED76-08438 **AMOUNT AWARDED:** $231,600

DATE AWARDED: July, 1976 **DURATION:** 24 months

PROJECT TITLE: AN INTEGRATED SHIP DESIGN SYSTEM AS AN AID TO ENGINEERING SCIENCE EDUCATION IN NAVAL ARCHITECTURE

PROJECT DIRECTOR: John B. Woodward

PROJECT ADDRESS: The University of Michigan
Ann Arbor, Michigan 48109
Phone No. 313-764-8551

PURPOSE:

The general objective is to organize naval architecture and marine engineering computer programs into an integrated system that can be used by faculty and students in teaching and learning ship design. The student is to be furnished with computational tools to the maximum extent feasible from available program libraries, including those that evaluate economic merit of technically feasible designs. He is also to be furnished data banks that maintain the current status of his design. The instructor is to be provided with access to the student's data banks and with supervisory programs that reduce his labor in evaluating student progress. Other data banks are to contain the variety of design data needed in this field.

AUDIENCE:

The integrated computer system is intended for use in teaching ship design at the senior undergraduate level. It is expected to be useful at all institutions teaching ship design, though with limits imposed by the capabilities of their computing facilities.

INNOVATION:

A basic innovation is the integration of diverse computer programs into modules of a single system, under the command of a versatile system executive. Although similar developments are taking place in the commercial world, this is the first such system designed for education use. It features checking routines to guide the student user away from errors, flexibility so that it may be adapted to different philosophies of instruction, and direct access by a teacher to the design data being developed by a student.

EVALUATION:

The project is to be evaluated on the basis of its benefit to ship design education by a review committee. This committee consists of four members appointed from other educational institutions, and from government and commercial organizations involved in computer-aided ship design.

MATERIALS:

All computer software will become available to other educational institutions. This includes full documentation. Syllabuses outlining courses of instruction using this computer system will also be published.

PROBLEMS:

A significant problem is the lack of computer programs covering several important aspects of ship design (Note: it was our intention to adapt existing programs, rather than write them). This problem is being mitigated by the continuing development of programs within the marine industry. Further, a companion project at the Massachusetts Institute of Technology will contribute programs, and some original programming work within the project should be possible during its late stages.

Another problem is the difficulty of transfer of our system to other institutions caused by differences in computers and in computer operating systesm. The remedy is effort applied to making modifications when the need is discovered.

ADDITIONAL COMMENTS:

None

February 1977

PROJECT NUMBER: SED 75-20185 A01 AMOUNT AWARDED: $299,810

DATE AWARDED: June 19, 1975 DURATION: 36 months

PROJECT TITLE: INSTRUCTIONAL MATERIALS AND DELIVERY SYSTEMS FOR AN UNDERGRADUATE CURRICULUM IN PEST MANAGEMENT FOR PLANT PROTECTION.

PROJECT DIRECTOR: David L. Armstrong

PROJECT ADDRESS: College of Agriculture and Natural Resources
Michigan State University
East Lansing, Michigan 48824
Telephone: 517/355-0234

PURPOSE:

The purpose of this project is to develop an undergraduate Pest Management Curriculum and associated instructional materials that may be readily adapted by a variety of academic institutions throughout the country. The instructional materials are being designed to be used in both the formal classroom as well as in non-traditional settings such as workshops, individual study and Cooperative Extension.

AUDIENCE:

The curriculum and its associated instructional materials are intended principally for undergraduates interested in pest management. The proposed materials are designed to provide students in established majors (Entomology, Horticulture, Plant Pathology, etc.) the necessary broad background and philosophy to function as pest management personnel. Students completing the curriculum may either terminate their formal education at the baccalaureate level or continue on to graduate school. Because of their versatility the associated educational materials will also be useful in many non-traditional educational situations.

INNOVATION:

Three areas of the project might be considered innovative:
(1) Interfacing materials for core pest oriented courses
(2) Mastery teaching of final three courses
(3) Computer based simulations for final three courses

Interfacing: A core of five existing pest-oriented courses (Economic Entomology, Plant Pathology, Vertebrate Control, Nematology and Weed Control) is utilized within the curriculum. Each of these will be transformed into a specialized pest management unit by interfacing. Interfacing is defined as self-contained educational materials whose subject material is germaine to both the course and the interdisciplinary philosophy of the curriculum but normally is not covered in the associated course. These interfaces may stand alone or be used as an integral part of the course. Interfaces are intended to serve three purposes:

1. Show the student that every control measure affects many aspects of an agroecosystem and thus initiate a thought pattern dealing with systems rather than single control measures.

2. Convert each pest-oriented course into a specialized pest management unit.

3. Interrelate each of the pest-oriented courses.

Providing classroom practice in managing multi-faceted and interconnected systems such as are found in an agroecosystem is no trivial matter. As a solution, the final three courses will be prepared on a mastery format combined with computer-based simulation and gaming. The body of the final three courses will be a mix of lectures, readings, laboratories and discussions concerning Pest Management - its philosophy and techniques. Proof of mastery will be based on a long-term project, the duration of which will extend through the final three courses. The objective of the project will be the design and management of an agroecosystem with a particular agricultural commodity in mind. The project will be reviewed periodically for progress, quality and consistancy with the philosophy of Pest Management by the educational staff. Simulations of sample situations will provide for (1) random events, (2) prediction, (3) trial and error, and (4) repair of mistakes. The merger of the mastery format and simulation and gaming is intended to assure that students finishing the curriculum will be able to bridge the gap between the classroom and real life situations.

EVALUATION:

There are two guidance groups associated with this project (1) a National Advisory Committee and (2) representatives from four cooperating institutions. Jointly these groups are responsible for advisement concerning curriculum content, trends in pest management and acceptability of the curriculum at the various types of institutions represented by the cooperating institutions. Evaluation of the developed materials will occur at three levels: (1) small student group analyses on the Michigan State University campus, (2) full class evaluations on the Michigan State University campus and (3) evaluation on campuses of the cooperating institutions. Evaluation at all levels will be a cooperative venture of the personnel responsible for developing the various components and the Michigan State University Learning and Evalution Services.

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MATERIALS:

When completed the project will make available three groups of materials:

(1) interfacing to pest oriented courses,
(2) mastery materials for the final three courses, and
(3) simulation and gaming materials for the final three courses.

The interfacing materials will be available primarily in auto-tutorial slide/tape presentations.

The main body of instructional materials for the final three courses will take the form of reading lists, syllabi and supplemental materials where necessary. Suggestions for use of these materials in coordination with the long-term project will also be prepared.

Several computer based simulations will be prepared. Instructors manuals for use of these simulations will also be available.

PROBLEMS:

Those responsible for preparing the various materials outlined should be knowledgeable of pest management, learning system design and the media in which the materials are to be prepared. Usually these three bodies of knowledge are not requisite in any one person. The proposed solution has been Learning System Design and Media Workshops for pest management personnel. These workshops are being conducted by the Michigan State University Learning and Evaluation Services.

February 11, 1977

Physics/History of Science

PROJECT NUMBER: SED 74-17738-A01 AMOUNT AWARDED: $117.240

DATE AWARDED: July, 1974 DURATION: 45 months

PROJECT TITLE: DISSEMINATION OF INSTRUCTIONAL MATERIALS: HISTORY OF PHYSICS LABORATORY

PROJECT DIRECTOR: Samuel Devons

PROJECT ADDRESS: Barnard-Columbia History-of-Physics
Laboratory, Barnard College, Columbia
University, New York, New York 10027.
(212) 280-5102

PURPOSE:

i) To make available to a number of institutions, covering a wide range of academic context, materials developed and used for several years in a History of Physics Laboratory.

ii) From the trial use of these materials, to assess the value and effectiveness of introducing a historical/experimental approach as part of instruction in science.

iii) To develop and adapt the materials, in the light of this experience, for such wider dissemination and use as seems appropriate.

AUDIENCE:

Principally college level; ranging, in particular cases, from science courses for liberal arts students, to substantial and relatively sophisticated projects for senior science majors.

Much of the material being distributed is addressed, in the first instance, to those (instructors) who are introducing this historical/experimental approach in their own institution, and who will use it as a basis for courses which they themselves arrange. Some of the material, for example, extracts from primary sources, is suitable for use by students directly.

INNOVATION:

The focus of the historical/experimental approach is to present the process of science discovery. Experiments, whether as demonstrations or as performed by the students themselves, are placed in as accurate a historical context as possible, from the standpoint of their motive and purpose, the scientific/technical means available, their outcome at the time, and their significance in the subsequent development of science.

EVALUATION:

Materials are being continuously distributed to participants for comment and criticism as well as for local adaptation and use. Workshop-meetings of the participating group are held bi-annually, where experience gained in the use of these, and other, materials is assessed, and guidelines for the continued development of the work are established. An overall evaluation of the project will be made by the group, and will be available for general circulation.

A steering committee comprises members representative of Physics, History of Science and Science-Education.

The participating group of institutions currently includes: Harvard University, Mass.; S.U.N.Y., Stonybrook, N.Y.; U.C.L.A., Cal.; University of Minnesota; New School of Liberal Arts, Brooklyn College, City University of N.Y.; Queensboro Community College, City University of N.Y.; Harrison High School, N.Y.; Montclair State University, N.J.; Rhode Island College, R.I.; Guilford College, N.C.; University of North Carolina at Chapel Hill, N.C.; North Carolina Agriculture and Technical State University, N.C.; Villanova University, Penn.; Western Illinois University, Illinois.

MATERIALS:

Materials provided, (which deal with topics in physics from classical antiquity to the 19th century) include: sketch of historical-scientific background, with some biographical details; detailed accounts of experiments; diagrams, drawings and notes to help in the reconstruction of the apparatus in a form suitable for a student laboratory and/or demonstrations; suggested questions and problems for students; bibliographies. Suitable collections of extracts from primary sources, and illustrative slides have also been prepared. For some topics, short historical/scientific films are being made, in collaboration with Columbia University School of the Arts; Film division. The purpose of these films is not so much didactic, as to capture the spirit of the laboratory and stimulate interest and inquiry.

Presently materials are available from the Project Director. At the conclusion of the project it should be possible to decide which materials are suitable for wider dissemination (through commercial publishers).

PROBLEMS:

The combination of historical study with laboratory investigation is certainly heterodox. Few putative instructors of a history-of-physics laboratory - even those enthusiastic about its potentiality - have had extensive experience, either in their own education or in their instruction, of this type of study. The participants divide roughly into two classes: one with strong background in history of science and only modest laboratory experience; the other with more orthodox experience of physics and limited acquaintance with its actual history. The primary needs of these two groups are complementary, and the major task is to meet both. There seems no lack of eagerness both to learn, and subsequently to teach. But the troubles and financial exigencies that now beset many "institutions of higher learning", do seem to restrict the energies that can be applied to an academic venture of this sort.

February, 1977

PROJECT NUMBER: SED74-00541

PROJECT TITLE: THE TECH PHYSICS PROJECT

PROJECT DIRECTOR: Philip DiLavore

PROJECT ADDRESS: Indiana State University
Terre Haute, Indiana 47809
(812) 232-6311 Ext. 5715

PURPOSE:

The aim of the Tech Physics Project was to produce instructional materials for the teaching of introductory physics in a "modular" form, and with a laboratory-oriented approach. Each module comprises a relatively independent unit of instruction, and each is based upon a technological device or system. The students' investigations are centered about the system and, in each module, only those topics which flow naturally from the study of the device are discussed. Approximately ten to twelve modules will form a one-year course, but twenty-eight were produced, so that the individual teachers are able to assemble sets of modules which are most appropriate for their students. Insofar as possible, the Project encourages individualized study of modules.

AUDIENCE:

The group of students at which the Physics of Technology modules were aimed at the beginning of the Project comprises those students who are in technician training or technology programs and who are taking a "technical physics" course. Thus far, the modules have been used widely by such students, but they have also had considerable use in other kinds of courses; for example, those for liberal arts students, pre-professional students and even in a number of high schools.

INNOVATION:

Unusual aspects of the Physics of Technology modules include the following:

1. Physics is taught by means of "real-world" devices.
2. The instructional units are three-week modules, which may be assembled from a much larger set than could be used in a whole year; the intention is that the teacher then can use those modules which are most appropriate for his students.

3. "Coverage" of topics in a traditional sense is not aimed for. Rather, it is intended that the students should get into the topics they do cover in more depth and that this treatment shall give them a feel for the methods and topics of physics. However, most of the traditional topics are covered in some modules and teachers may choose which topics they wish to include by appropriate choices of modules.

4. Generalization into broad, physical principles follows from specific observations by the student of the particular principle in action in the device being studied.

EVALUATION:

Each of the four centers which were responsible for writing the Physics of Technology modules did some field testing of modules as they were being developed. Modules were tested in as many schools and with as many classes as possible; the resulting information was used for the revision of modules.

During the 1974-1975 academic year, a limited program of classroom trials was conducted in about ten independent two-year and four-year colleges. Usage ranged from commitments to a full year's course based entirely on modules to the inclusion of one or two modules in a traditional liberal arts course. Generally, both students and teachers were enthusiastic about the approach and format. Teachers now using the modules find a complete and sudden switch from traditional course materials a bit difficult to implement, but they remain enthusiastic about the reception of modules by the students.

MATERIALS:

Below is a list of the Physics of Technology modules. They are available from the McGraw-Hill Book Company. The code beside each indicates at which production center the module was written, as follows:

FVCC - Florissant Valley Community College
St. Louis, MO 63135
Project Director: Bill G. Aldridge

ISU - Indiana State University
Terre Haute, Indiana 47809

ORAU - Oak Ridge Associated Universities
Oak Ridge, TN 37830
Project Director: Homer C. Wilkins

SUNY - State University of New York at Binghamton
Binghamton, NY 13901
Project Directors: Carl R. Stannard
Bruce B. Marsh

TERC - Technical Education Research Centers
Cambridge, MA 02139
Project Director: John W. McWane

The ANALYTICAL BALANCE: A Module on Measurement, Errors and Mechanical Equilibrium	FVCC
AUTOMOBILE COLLISIONS: A Module on Momentum and Energy	SUNY
The AUTOMOBILE IGNITION SYSTEM: A Module on Electricity and Magnetism	FVCC
The BICYCLE: A Module on Force, Work and Energy	ISU
The BINOCULARS: A Module on Waves, Physical Optics and Geometrical Optics	FVCC
The CAMERA: A Module on Optics and Photographic Measurements	FVCC
The CATHODE RAY TUBE: A Module on Electric Fields and Forces	SUNY
The CLOUD CHAMBER: A Module on the Detection of Radiation and Phase Changes	ORAU
The ELECTRIC FAN: A Module on Rigid Body Rotation	TERC
The FLUORESCENT LAMP: A Module on Atomic Physics	ORAU
The GEIGER COUNTER: A Module on Electrostatics and the Detection of Radioactivity	ORAU
The GUITAR: A Module on Wave Motion and Sound	FVCC
HYDRAULIC DEVICES: A Module on Hydraulics and Equilibrium	SUNY
The INCANDESCENT LAMP: A Module on Thermodynamics, Current Electricity, and Photometry	FVCC
LASER LIGHT: A Module on Modern Optics and Quantum Mechanics	FVCC
The LOUDSPEAKER: A Module on Sound	TERC
The MULTIMETER: A Module on Current Electricity	SUNY

PHOTODETECTORS: A Module on the Interaction of Light and Matter	TERC
The PILE DRIVER: A Module on Kinematics, Work, and Energy Transformation	FVCC
The POWER TRANSISTOR: A Module on Heat Transfer	TERC
The PRESSURE COOKER: A Module on the Thermal Properties of Matter	TERC
The SLIDE PROJECTOR: A Module on Geometrical Optics	TERC
The SOLENOID: A Module on Magnetism	SUNY
The SPECTROPHOTOMETER: A Module on the Spectral Properties of Light	TERC
The STROBOSCOPE: A Module of Motion	SUNY
The TOASTER: A Module on Heat and Energy Transformations	SUNY
The TORQUE WRENCH: A Module on Forces, Torques, and Elasticity	SUNY
The TRANSFORMER: A Module on Magnetic Properties of Matter and Alternating Currents	SUNY

PROBLEMS:

The Physics of Technology modules were written at four differend Production Centers, each funded with its own independent grant. The "coordination" of these centers was done from a central office, under a fifth grant. A Steering Committee was responsible for policy making and quality control. With about fifty persons in widely scattered locations working on the Project, communications were difficult; sometimes even basic agreement on the aims and methods of the Project was difficult to reach.• Perhaps such problems are inherent in a project of this scope.

Although the cooperation and assistance of the Division of Science Education Development and Research was excellent, serious problems were caused by the unresponsiveness of the Office of Contracts and Grants and of the legal officers of the NSF, prolonging the negotiation of the contract with the publisher for years.

ADDITIONAL COMMENTS:

The apparatus for the Physics of Technology modules is produced and distributed by Thornton Associates, Inc.

February, 1977

PROJECT NUMBER: SED 75-01304 AMOUNT AWARDED: $85,720

DATE AWARDED: January 1, 1975 DURATION: 21 months

PROJECT TITLE: THE VAN ALLEN CONNECTION - A FILM ABOUT THE EARTH'S MAGNETOSPHERE

PROJECT DIRECTOR: Robert H. Eather

PROJECT ADDRESS: Physics Department
Boston College
Chestnut Hill, MA 02167
(617) 969-0100 (Ext. 3595)

PURPOSE:

This is a ~50 minute film to show the enormous advances made in the past 15 years in our understanding of the magnetic environment around our earth; this is the region studied by hundreds of satellites during this period, so the film essentially presents the results of one of the most active areas of the Space Program. The film includes footage of the sun and aurora and animation sequences.

AUDIENCE:

General public, high school, college. The film is intended for national educational television.

INNOVATION:

This will be the first film to present the science of what we have learned about the magnetosphere at a level appreciated by general audiences. Human and historical aspects will enhance the film appeal. Completion is planned to coincide with the start of the International Magnetospheric Study, a 3 yr international co-operative program to study the magnetosphere.

EVALUATION:

An advisory committee consisting of scientists (at NASA, NSF, Boston College), filmmakers (at PBS Channel 2 in Boston) and 'general public representatives' have reviewed the final script, and will review the film at rough-edit stage.

MATERIALS:

16 mm color film, approx. 50 minutes. A shorter version (~10-15 minutes) emphasizing the science will also be produced specifically for NASA and at their expense. The longer film will be distributed through National Audiovisual Center and the short version distributed by NASA.

PROBLEMS:

Continuity of funding because of hold ups in interregency transfers between NASA and NSF.

ADDITIONAL COMMENTS:

Of total funding of $85,720, NSF provided $58,720 and NASA provided $27,000.

In view of the milliors of $ spent on space research in the past 15 years, we feel that scientists have been lax in informing the general public (in a readily appreciable format) of the new science that has been discovered. It is hoped this film will fill that need.

Film completed January, 1977.

February, 1977

PROJECT NUMBER: SED 74-04822 AMOUNT AWARDED: $26,750

DATE AWARDED: May 15, 1974 DURATION: 5 months

PROJECT TITLE: College Faculty Workshop on Physics and the Arts.

PROJECT DIRECTOR: Ronald D. Edge

PROJECT ADDRESS: Physics Department
University of South Carolina
Columbia, South Carolina 29208 (803) 777-8104

PURPOSE: During the past ten years the enrollments of the University of South Carolina in Art, Music, Theater and Journalism have grown until they are nearly as large as the number of students who intend to seek careers in Science, Engineering or Medicine. An understanding of the Physics of Music and Art is an essential part of the education of this group. We are meeting this need. However, the number of laboratory experiments and demonstrations readily available for such students which, simultaneously illustrate the physical principle we wish to emphasize and are relevant to art or music, is limited. The familiar experiments are designed for future scientists and such experiments frequently involve apparatus which, though sufficient to tain the results, are scarcely stimulating to the student, particularly to students of art and music whose approach to experiments is so different. In the College Faculty Workshop a series of new experiments was designed for a course in physics in the arts and music. These were published in a laboratory manual which is available for general distribution.

The unifying principle for most of these experiments is wave-motion. Most students of art and music have very little understanding of waves, even though light and sound are their means of perception. A significant difference between the experiments we devised and those already available was the relevance for the artist and musician. The experiments were designed to use equipment normally available in the college physics laboratory, or which could be obtained relatively inexpensively.

AUDIENCE: This project was developed especially for students of art and music. It might also be used by suitably oriented high school students.

INNOVATION: The course was geared to the attitudes of the students which, in many respects, differed from those of scientific background. In many ways it is quite difficult for a scientist to relate to such students since their outlook on life is so different. A distinct effort was made to overcome this problem. Since the workshop was held, these experiments have been used in courses taught at USC and elsewhere with considerable success.

MATERIALS: The manual which was produced is available to those interested if they will write to:

R. D. Edge
Physics Department
University of South Carolina
Columbia, South Carolina 29208

PROBLEMS: The difficulties that arise in general in a course of this nature lie in selecting amongst the very many experiments those which seem to be most suitable. The lack of a mathematical background on the part of the students restricts one to qualitative rather than quantitative experiments for the main part, and stimulating the students to think mathematically can be quite difficult. Nevertheless they pick up an intuitive feel for the fundamental properties of wavemotion, and the physical operation of musical instruments, and the meaning of color and light in art.

April 1977

Physics
Chemistry
Biosciences

PROJECT NUMBER: SED72-01145 A01 AMOUNT AWARDED: $76,620

DATE AWARDED: January 1, 1975 DURATION: 20 months

PROJECT TITLE: PHYSICAL SCIENCE MODULES FOR BIOSCIENCE STUDENTS

PROJECT DIRECTOR: Robert G. Fuller

PROJECT ADDRESS: Behlen Laboratory of Physics
University of Nebraska-Lincoln
Lincoln, NE 68588
(402) 472-2790

PURPOSE:

This is a feasibility project to develop a system to infuse into introductory college physics and chemistry courses examples and applications drawn from the biological sciences including medicine and allied health. Physics and chemistry departments in many colleges and universities are developing courses designed for bioscience students. These courses vary in content from chemistry for nurses to topics in biophysics. Such courses extend beyond the content boundaries delineated by traditional textbooks. Consequently, many college teachers have been writing and using their own course materials. In general these materials are restricted by each teacher's limited time and expertise. This project is to establish a system that will find these locally developed materials, review their quality, unify their format, test them in appropriate classroom situations, revise them if necessary and disseminate them nationally. This project will produce -

1. A detailed exposition of the physical science needs of bioscience students in a number of selected content areas. This exposition will include both the specific content and reasoning skill requirements. The physical science needs will be grouped into various categories by content and by bioscience specialty. This exposition will be the basic data for the development of physical science learning materials to satisfy these needs.
2. An annotated index of materials presently available in these selected content areas. The materials will be categorized by content and reasoning level.
3. A scheme for organizing modular materials appropriate for those selected content areas.
4. Two sample clusters (a total of 12 modules) illustrating appropriate content, approach, level, quality, and organization.
5. An open system of participation for educators to foster the cooperative exchange of these materials.

Copies of these products are to be distributed to physics and chemistry departments around the country.

AUDIENCE:

The primary audience is the college students who are intending a career in one of the biosciences including medicine and allied health. All of these students have some physics and chemistry prerequisites to meet in preparation for their professional training. The modules developed in this project are to bring the basic physical science principles into direct contact with their bioscience applications. It is expected that certification renewal programs will also find these modules useful.

INNOVATION:

The open system of participation for educators who have developed modular materials for their own classroom use is new to the physical sciences. Furthermore, modules that bring basic scientific principles into direct contact with modern, relevant bioscience applications are unique. Students using these modules are expected to have a much better grasp of the basic scientific principles as well as higher motivation in studying science. The likelihood of success of this project is unknown, since it is not presently known whether there are any number of physical science educators who have developed good quality modules of this type and who will share those modules with other educators through this system.

EVALUATION:

The project will be evaluated on the basis of its ability to produce good quality modules that become widely used. The quality of the modules will be evaluated by students, teachers and content experts. There will be trial teaching and national steering committee evaluations of the modules before they become available for wide spread dissemination.

MATERIALS:

Three preliminary modules have been written and classroom tested, Osmosis by Allen Killpatrick (Johnston College), Diffusion by Allen Killpatrick (Johnston College), and Thermal Transport Processes in The Human Body by Thomas Campbell (Illinois Central College). A preliminary module on Chelation by Margaret Rodenberg (Kittering School for the Medical Arts) is in final preparation. Content outlines of modules on Colloids and Separation Processes are in preparation. A Teaching Resource Letter of Physical Science Materials for Bioscience Students has been prepared. Copies of these materials are available from the project director.

PROBLEMS:

1. We have not been able to find many modules that educators have already developed that connect physical science concepts to their bioscience applications.

2. The physics and chemistry professions differ greatly in their approach to bioscience students and in their interest in modular materials for bioscience students.
3. The coordination of this project with other projects such as SABLE, UMAP, Ecosystems, and PHYSMOD and with MCAT committee is a complex task.

February, 1977

PROJECT NUMBER: SED75-11210 A01 AMOUNT AWARDED: $57,320

DATE AWARDED: May 1, 1975 DURATION: 7 months

PROJECT TITLE: KELLER PLAN CALCULUS-BASED PHYSICS MODULES

PROJECT DIRECTOR: Robert G. Fuller

PROJECT ADDRESS: CBP Workshop
Behlen Laboratory of Physics
University of Nebraska-Lincoln
Lincoln, NE 68588
(402) 472-2790

PURPOSE:

This project began as a college faculty workshop during which time 15 experienced Keller Plan instructors wrote a complete set of modules for a calculus-based, general physics course. Each module includes learning objectives, references to assignments in each of five leading textbooks,[1-5] problems with solutions, a practice test, and three forms of mastery tests with grading keys. The workshop completed 43 study modules for physics plus three calculus background modules, an orientation module, review tests and an appendix on how to use the Keller Plan.

AUDIENCE:

These modules are intended for use in the calculus-based general physics course usually required for engineering students and physical science majors.

INNOVATION:

A complete set of materials were written in only three weeks by the concentrated efforts of 15 experienced educators and the workshop staff. These materials make use of the Keller Plan with the calculus-based, general physics course accessible to any college or university physics department.

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[1] Introduction to Physics for Scientists and Engineers, Frederick J. Bueche (McGraw-Hill, New York, 1975), second edition.

[2] Fundamentals of Physics, David Halliday and Robert Resnick (Wiley, New York, 1970; revised printing, 1974).

[3] University Physics, Francis Weston Sears and Mark W. Zemansky (Addison-Wesley, Reading, Mass., 1970), fourth edition.

[4] Elementary Classical Physics, Richard T. Weidner and Robert L. Sells (Allyn and Bacon, Boston, 1973), second edition, Vols. 1 and 2.

[5] Physics, Paul A. Tipler (Worth Publishers Inc., New York, 1976).

EVALUATION:

During the workshop all the modules were evaluated by the other workshop participants. In addition five students were hired as a part of the workshop staff to read all of the modules, to work the problem assignments, and the mastery tests. These materials are currently being distributed for wide scale classroom use.

MATERIALS:

This project has developed a complete set of Keller Plan study modules for a one year course in calculus-based general physics. These materials are available in a complete set, open copyright, for the cost of printing and mailing, $15, from CBP Workshop, Behlen Laboratory of Physics, University of Nebraska-Lincoln, Lincoln, NE 68588. Twelve hundred copies of these materials have been distributed to a wide variety of educational institutions.

PROBLEM:

These completed materials now need to be distributed as student study guides and an instructor's mastery test booklet by commercial textbook publishers. The task is to arrange a proper transfer of these materials to the commercial sector.

February, 1977

STUDY MODULES FOR CALCULUS-BASED GENERAL PHYSICS*

Study modules for *Calculus-Based General Physics (CBP)*, based on personalized, self-paced modules, have been developed by a team of leading educators experienced in this field and will soon be available for your use.

CBP WORKSHOP

Each of the 15 participants in the CBP Workshop, held in Colorado during the summer of 1975, contributed materials used in his own student-tutored, mastery-oriented general physics course based on calculus. From the study units, discussion questions, review units, and exams made available through this resource, a comprehensive set of materials called CBP was generated. The flexible nature of the CBP materials will allow them to be easily adjusted to most course formats.

UNIQUE FEATURES

- Complete Set of Mastery Exams and Grading Key (Three equivalent exams for each module)
- Student Practice Exams
- Supplementary Student Exercises with Detailed Solutions
- Keyed Directly to Popular Physics Textbooks
- Open Copyright

CBP MATERIALS

The CBP materials consist of 45 study modules, 3 mastery tests for each module, a complete grading key, and an instructor's guide. The modules are directly keyed to the four most commonly used calculus-based physics textbooks,* and are readily adaptable to many other similar texts.

The fundamental purpose of this program is to provide physics departments across the country with an additional, accessible resource for calculus-based physics courses. This resource can have a variety of classroom applications. When used in lecture–recitation courses, these modules can provide enrichment and additional materials for outside classroom work. They also can be used to offer an alternative self-paced style of instruction for calculus-based physics. Since development of systems of personalized instruction is extremely time consuming for individual schools, the National Science Foundation has funded the CBP Workshop as a means of making high-quality, student-tested modules available throughout the nation. The CBP Modules are the result of a total of 20 years of testing by the Workshop participants. Throughout this development, and at each stage during the Workshop, there has been student feedback concerning the level of clarity in each topic.

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*Funded by the National Science Foundation.

CBP MODULE AUTHORS

- *Owen Anderson* (Bucknell University)
- *Stephen Baker* (Rice University)
- *Van Bluemel* (Worcester Polytechnic Institute)
- *Fernand Brunschwig* (Empire State College)
- *David Joseph* (University of Nebraska – Lincoln)
- *Robert Karplus* (University of California – Berkeley)
- *Michael Moloney* (Rose Hulman Institute of Technology)
- *Jack Munsee* (California State University – Long Beach)
- *Gary Newby* (Boise State University)
- *Ivor Newsham* (Olivet Nazarene College)
- *William Snow* (University of Missouri – Rolla)
- *Willard Sperry* (Central Washington State College)
- *Robert Swanson* (University of California – San Diego)
- *James Tanner* (Georgia Institute of Technology)
- *David Winch* (Kalamazoo College)

Workshop Staff

- *Robert G. Fuller*, Director (University of Nebraska – Lincoln)
- *Albert A. Bartlett* (University of Colorado)
- *Thomas C. Campbell* (University of Nebraska – Lincoln and Illinois Central College)
- *Harold Q Fuller* (University of Missouri – Rolla)

February, 1977

PROJECT NUMBER: SED74-09024 A02 **AMOUNT AWARDED:** $305,775

DATE AWARDED: January 3, 1974 **DURATION:** 1/31/74 - 4/30/77

PROJECT TITLE: UNDERGRADUATE PROGRAM FOR PHYSICS-CHEMISTRY TEACHERS

PROJECT DIRECTOR: Uri Haber-Schaim

PROJECT ADDRESS: Institute for Curriculum Development in Science
and Mathematics (formerly Physical Science
Group), Boston University, 38 Cummington St.,
Boston, Mass. 02215 617/353-4246

PURPOSE:

The Program was designed to educate future secondary school teachers who will be well qualified to teach physics and chemistry--and any reasonable combination thereof--from the eighth grade to the twelfth grade.

AUDIENCE:

Whereas the four-year Program in its entirety is aimed at future physics-chemistry teachers, individual courses apply to a much broader spectrum of students. In particular, lower division courses can satisfy science and mathematics requirements for a wide range of undecided students as well as declared majors in the natural and social sciences. (See section under materials for details.)

INNOVATION:

(A) The integration of substance and methodology. Instead of handling the substance of the science and the teaching of science in separate and usually unrelated courses, students in the Program learn science in the ways they are expected to teach it. Specifically, simple experiments and their analysis play a central role.

The materials were developed in such a way as to encourage active student participation in peer teaching, in solving problems at the board, in summarizing experiments, and in developing tests right from the beginning of the freshman year. Early involvement with the schools, including school visitations, also starts in the freshman year.

(B) Integration of physics and chemistry at the introductory and upper levels. Economy in time, as well as the unified approach to natural phenomena, is thus accomplished.

(C) Correlation of subjects in different courses. By being conscious of the activities of the student in various courses, a reinforcement of learning in the freshman year, specifically in science, mathematics and English, has been achieved.

(D) Attention to auxilliary skills. A competent science teacher should possess the basic shop skills needed to build and repair the kind of equipment used in a physics or chemistry laboratory. A course for this purpose has been developed.

EVALUATION:

Detailed feedback on pilot professors and classroom visits at the pilot colleges were used to evaluate the pilot editions of the materials and some of the later revisions.

Observations at pilot colleges and follow-up of graduates in their student teaching were carried out by an outside evaluator. Results to date clearly show that the scheme works: The graduates acquired sound teaching skills and were found to be superior in adaptability, resourcefulness, awareness of students' needs, and degree of professional development.

MATERIALS:

The following materials are currently available directly from the Institute for Curriculum Development.

(A) A detailed description of the Program, including evaluations and guidelines for implementation. Free.

(B) Elementary Chemistry: An Experimental Approach by the Physical Science Group: $9.75 (plus 50¢ shipping and handling). Main topics include: conservation of mass, macroscopic characteristic properties of matter; mixtures, compounds and elements, and the laws of definite and multiple proportions; the atomic model and the mole; conservation of electric charge, electrons, ions and electrochemistry; periodic table of elements. A free teacher's guide is available with class orders.

(C) Energy: An Experimental Approach by the Physical Science Group: $4.50 (plus 50¢ shipping and handling). Main topics include: heat and specific heat; electric charge, voltage, electrical work, and resistance; gravitational potential energy, elastic potential energy; kinetic energy; forms of internal energy: the conservation of energy; radiant energy; photons. A free teacher's guide is available with class orders.

(D) Applied Mathematics: An Introductory Course by the Physical Science Group: $8.50 (plus 50¢ shipping and handling). Main topics include: numbers resulting from measurements, handling significant digits; comparing numbers, comparing sets of numbers, histograms and frequency distributions; estimations, first-order approximations; slide rules and the logarithmic scale; programming, loops and branches, elements of BASIC; properties of linear and power functions, finding analytic expressions from graphs; basic properties of derivatives and anti-derivatives; properties and applications of exponential and logarithmic functions; basic properties of trigonometric functions.

Necessary algebraic skills are reviewed in three appendices.

(E) Basic Shop Skills in Wood, Metal, Circuits, Glass by the Physical Science Group: $9.50 (plus 50¢ shipping and handling). Through a series of projects the competencies in using various hand and power tools, such as hand saw, square, nail hammer, files, table saw, and drill press, are developed. Building and testing electric circuits, and cutting, bending and sealing glass tubing make up the electronic and glass sections of the course. Appendices deal with sharpening tools and operations on a metal-working lathe, and use of the cathode-ray oscilloscope.

All the above-mentioned texts, plus a text on Applied Calculus (formerly referred to as Applied Mathematics 2, have now been put up for bids to commercial publishers.

A detailed syllabus for a course in English for science majors developed in conjunction with a program by D. Newton Smith is available from Ted C. Moody, Director, Physics-Chemistry Teachers Program, Western Carolina University, Cullowhee, North Carolina 28723.

PROBLEMS:

The major problems encountered in implementing the Program are managerial in nature. That is, good planning is required to secure the necessary approvals for curriculum committees, etc. to make the courses available to a wide enough spectrum of students so as to have economically viable sections. For how to avoid some and solve others, see the guidelines for implementation in the detailed description of the program.

February 1977

PROJECT NUMBER: SED-7419548 AMOUNT AWARDED: $66400

DATE AWARDED: Sept. 23, 1974 DURATION: 34 months

PROJECT TITLE: REACH*KIT: RESEARCH EXTENDED AS CLASSROOM HELP

PROJECT DIRECTOR: Michael Lieber

PROJECT ADDRESS: University of Arkansas
Fayetteville, AR 72701
(501) 575-2506

PURPOSE:

REACH*KIT (Research Extended As Classroom Help) is intended to stimulate student interest in introductory college-level physics courses by making possible the introduction of important current research into the curriculum. A flexible multimedia kit is made available to the instructor containing 35-mm slides, taped interviews with researchers, and materials suitable for making overhead transparencies, together with detailed technical supporting text. The emphasis in the materials is the physical content, while the overall package has been designed to facilitate use in a wide variety of situations. For the prototype kit the subject area chosen was research related to the development of new energy sources, an area where text material is generally lagging far behind research.

AUDIENCE:

REACH*KIT is aimed at the college-level physics classroom. By selecting materials from the kit, the instructor can adapt the presentation to a wide variety of courses, from science-and-society courses to intermediate physics courses for physicists and engineers. Much of the material could readily be adapted to high school use, although this has not been attempted. In fact the REACH*KIT team, members of the University of Arkansas Physics faculty, have already used the materials in presentations to high school groups and to graduate-student technical colloquia.

INNOVATION:

(1) There is no other source for most of this material. The available materials are either at the popular level, with too little technical content to be of use to the teacher, or at the technical report level, often not readily accessible, and lacking the background discussion necessary to make it useful. Very little of the material is in classroom-ready form.

(2) The kit is prepared by a team of physicists who are both active teachers and active researchers. As such they are ideally

suited to interface between the research and the classroom. As researchers themselves they can better communicate with the researchers and get both the overall picture and the technical details. As experienced teachers they can ensure that the most useful materials are obtained for use in the classroom presentation.

(3) The professional status of the REACH*KIT team of four physicists facilitates entrance into laboratories and closer contact with the researcher himself, rather than with public relations or other buffer personnel. This was borne out by our experience.

(4) The coverage of the prototype kit is broad and technically sophisticated. Yet sufficient background material, leading back to basic physics, is provided, as needed by the instructor not expert in the particular research area.

(5) Based upon presentations already made by members of the REACH*KIT team, from high school audiences to graduate students, and at meetings of the American Association of Physics Teachers, we believe the liklihood that the materials will be successfully used in the classroom is quite high.

EVALUATION:

The prototype REACH*KIT will be evaluated for educational benefits and effectiveness, and for eventual commercial marketability. The latter evaluation will be made by faculty members of the Departments of Management and Marketing in the College of Business Administration. The educational impact will be evaluated by the REACH*KIT team in the Department of Physics, based upon returned questionnaires from recipients of the prototype REACH*KIT. The recipients, 250 in number, are chosen from a randomly selected sample of college-level institutions involved in teaching physics, plus a small number of specially selected schools to assure a reasonable number of responses. The prototype kit is distributed free of charge.

MATERIALS:

The prototype kit contains 160 35-mm slides, two 60-minute tape cassettes of selected interviews, and approximately 300 pages of text material. Because of high cost, the overhead transparencies were omitted. However, numerous full-page figures in the text were included, of such size and nature (predominately line drawings) to make them suitable for production of overhead transparencies by the Xerox or Thermofax processes. The whole kit fits in a specially-prepared loose-leaf notebook. Subjects covered are: Fusion (with a general Overview, and sections on Tokamaks, Mirrors, High Beta, and Inertial Confinement), More Efficient uses of Natural Resources (with subsections on LMFBR, Laser Isotope Separation, and MHD) and Energy from the Sun and Earth (with sections on Solar Sea Power, Wind Power, Geothermal Energy, Photovoltaic Energy, Solar Central Power, Solar Thermal Energy).

PROBLEMS:

The principal problem encountered was the long delay in producing the kit, which was, in turn, caused by the large size and expanded scope of the prototype. The enlarged kit is the result of a desire on the part of the four REACH*KIT team members to develop a more useful product. During our interview trips we gathered excellent materials in many different areas, which we decided to include because of their potential utility to physics instructors. We also did not anticipate the large amount of background material that was necessary to make the treatment of various areas reasonably self-contained and accessible to the physics instructor with non-specialist training in the particular research area (in this respect we faced problems similar to those confronting the teacher of the target class). The one summer that the team had to work was almost entirely consumed in the interview trips and preparation for them. Thus the task of preparing the kit, especially the writing of the text, had to be performed during the school year in competition with many other responsibilities. We have solved these problems in the only way possible: large expenditures of faculty time.

ADDITIONAL COMMENTS:

We feel that the large prototype kit we have produced is an extremely useful tool for the college teacher of physics. If commercial distribution of the kit proves unfeasible, we could make the materials available for distribution to all interested parties, for the cost of reproduction, through the American Association of Physics Teachers and their highly successful "slide sales". However, the limitation of having only one summer in which to work, and gain experience, did not allow us to test the "quick response" to a single research "breakthrough" that was featured in the original proposal. We now feel that such a scheme would work well with a single faculty member handling an entire kit, if time and funds were made available to him on a continuing basis. However, such a narrow-concept REACH*KIT would have, in all liklihood, a correspondingly narrower appeal to the college instructor.

Finally, in retrospect, it would probably have been wise for us to request some additional funds in the grant extension to permit us to make a more concentrated joint effort to complete the kit during summer 1976.

February 1977

PROJECT NUMBER: SED76-00169 A01 AMOUNT AWARDED: $5,900

DATE AWARDED: November 1, 1975 DURATION: 16 months

PROJECT TITLE: WORKSHOPS ON TEACHING STRATEGIES IN UNDERGRADUATE PHYSICS

PROJECT DIRECTOR: Melba Phillips

PROJECT ADDRESS: American Association of Physics Teachers
Graduate Physics Building
SUNY at Stony Brook
Stony Brook, NY 11794

PURPOSE:

An AAPT planning committee prepared a set of modular workshop materials that has been used to introduce physics instructors to Piaget's model of intellectual development. Modules deal with problem-solving processes, Piaget's theory, textbook analysis, homework and examination questions, laboratory design and an extension of Piaget's work to encompass concepts classification and instructional techniques designed to enhance a student's ability to understand physics. Workshop audio-visual materials are available on a loan basis.

AUDIENCE:

The workshop materials are aimed at physics instructors who are teaching introductory courses.

INNOVATION:

The workshop is constructed so that a teacher who completes the workshop and suggested reading can conduct a workshop for others. Using audio-visual materials available from project headquarters a teacher can conduct a workshop for his/her colleagues. Over 1,000 physics teachers have participated in these workshops.

EVALUATION:

The initial evaluation by the AAPT planning group and participants provided useful information that was incorporated into a revised version of the modules. The revised materials were in use during 1975-76. Further evaluations of the revised materials have been conducted by AAPT.

MATERIALS:

The revised workshop package consists of 11 modules which include videotapes, a commercial 16 mm film, 8 mm cartridge film loops, audiotapes and a puzzle designed to serve as an analog of the "self-regulation" process. These materials are available on a loan basis for a small fee that covers the handling, postage and maintenance of the audio-visual materials. Interested persons may contact the AAPT Executive Office for full details on obtaining single copies of the printed workshop materials or multiple copies together with the audio-visual materials for workshop use. Telephone advice can be obtained from members of the AAPT Executive Office or the planning group:

Francis Collea, Dept. of Science Education, California State University, Fullerton, CA 92634, 714-870-2011;
Robert Karplus, Lawrence Hall of Science, University of California, Berkeley, CA 94720, 415-642-7166;
Robert Fuller, Dept. of Physics, University of Nebraska, Lincoln, NE 68508, 402-472-2790;
Lester G. Paldy, Dept. of Physics, SUNY at Stony Brook, Stony Brook, NY 11794, 516-246-6492 and
John Renner, College of Education, University of Oklahoma, Norman, OK 73069, 405-325-5723.

PROBLEMS:

Workshop leaders sometimes attempt to present the entire workshop in a time period which is too short. Planning tips for abbreviated workshops are being prepared. Delays in the return of borrowed materials and improper packing which results in breakage of materials have been experienced.

February, 1977

PROJECT NUMBER: SED 71-04408 **AMOUNT AWARDED:** $209,612

DATE AWARDED: May 28, 1971 **DURATION:** 56 months

PROJECT TITLE: THE PRODUCTION OF MODULES OF INSTRUCTION IN PHYSICS - TECH PHYSICS PROJECT (SUNY GROUP)

PROJECT DIRECTORS: C. R. Stannard, SUNY-Binghamton
B. B. Marsh, SUNY-Albany

PROJECT ADDRESS: State University of New York at Binghamton
Binghamton, New York 13901
Phone No. (607) 798-2868

PURPOSE:

The goal of the Tech Physics Project has been the production of instructional materials for the teaching of introductory physics with a device-oriented approach. In contradistinction to the more traditional physics approach where abstract principles precede their applications, in the Physics of Technology Series, the physics is introduced by means of real technological devices or systems and is then generalized to develop the abstract principles. The format is a series of device-centered modules. Each Physics of Technology module is based on a technological device or system and forms a relatively independent unit of instruction, during the course of which the student's investigations are centered about the device, treating those topics of physics which derive most naturally from it. The SUNY Group has produced nine of the 26 modules prepared by the Project. The modules are designed to facilitate individualized study if desired.

AUDIENCE:

The Tech Physics modules are intended as textual and laboratory material to be used in technical physics courses for students in two-year technical or technology programs. In addition to the wide use which they have had in the technical areas, they have also been well received by other diverse groups such as liberal arts classes, pre-professional programs and many high school classes.

INNOVATION:

Each Physics of Technology module is based on the study of a "real-life" device. The physics is extracted as the student works with the device, and is then generalized into more abstract broad physical principles. This contrasts with the traditional approach where the abstract principles are studied in detail in a classroom format and may then be applied to real systems. The level of abstraction is further reduced because the extensive laboratory investigations are begun early and are intimately interwoven with the classroom study.

Another innovative aspect of the project is the fact that the modules, each of which is designed to require two to three weeks of study, can be selected and combined to produce a coverage that is most appropriate to the needs of the students involved. This may not coincide with the traditional coverage, although most of the traditional topics are available in one of more of the modules. Because the modules can be used for individualized study, it is even possible for different students to follow different paths in the same class.

EVALUATION:

Our field-testing program was an important factor in the development of the modules, since it provided the student and instructor feedback necessary to revise the various drafts. Most of our modules were field-tested in as many editions as possible in as many schools as possible, including two-year technical colleges, liberal arts colleges, and high schools. In the case of the later modules, where in some cases feedback was needed before a school could fit a module into the curriculum, we had students from nearby Broome Community College work through the modules on their own, with the staff acting as tutors where necessary.

In addition to the local efforts, the National Project Coordinator and his assistant conducted an extensive national field test not only of the individual modules, but also of the modular course concept.

MATERIALS:

The Physics of Technology modules were published in 1975 by McGraw-Hill Book Co. The apparatus is available from Thornton Associates, Inc.

The modules produced at SUNY-Binghamton are: Automobile Collisions - Momentum & Energy; The Cathode Ray Tube - Electric Fields & Forces; Hydraulic Devices - Fluids; The Multimeter - Current Electricity; The Solenoid - Electricity & Magnetism; The Stroboscope - Forces & Motion; The Toaster - Heat & Energy Transformation; The Torque Wrench - Forces, Torque & Elasticity; The Transformer - Electricity & Magnetism.

PROBLEMS & RETROSPECTIVE COMMENTS:

These comments are intended to help others who may attempt future projects which may encounter problems similar to those that we have overcome.

The fact that the Tech Physics Project was organized with several production centers across the country, had the very positive result that the project had a remarkably wide diversity of geography, pedagogy and type of institution, assuring a more national outlook which the project might not have had, had it been more localized. This diversity however, was purchased at the price of difficulties in communication, coordination and in the early determination of the patterns which the developing project should follow. The effect of all these problems was to produce some misunderstandings between various segments of the project simply because direct communications was not easy and, perhaps more significantly, because the pressures of time were in many cases very severe. On balance, nevertheless, the SUNY Group feels that the national character of the Project was worth the coordination problems that it generated.

In summary, the SUNY Group feels that the multiply-centered project can produce quality instructional materials and that the value of the incorporation of a truly national outlook argues for it, but that it is of crucial importance that the multiply-centered project operate under a more open time-frame than would a local project of the same scope. We feel that the experience of the Tech Physics Project would help any future multiply-centered project to arrive more quickly at operating procedures. This alone would relieve many of the pressures.

February 1977

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PROJECT NUMBER: SED-6100100 **AMOUNT AWARDED:** $575,830

DATE AWARDED: June, 1971 **DURATION:** 72 months

PROJECT TITLE: CREATION, EVALUATION AND DISSEMINATION OF TEACHING MATERIALS AND LEARNING FORMATS IN COLLEGE PHYSICS

PROJECT DIRECTOR: Edwin F. Taylor

PROJECT ADDRESS: Department of Physics
Room 20B-136
Massachusetts Institute of Technology
Cambridge, Massachusetts 02159
(617) 253-6040

PURPOSE:

The purpose of this project is to complete a new set of texts, films, and other learning materials in college physics; to study non-traditional learning formats in physics; and to investigate how educational innovations (with careful attention to their human effects) become self-propagating.

AUDIENCE:

The teaching materials are intended for use by college students with a strong interest in physics; reports on the non-traditional learning format are intended for college and university teachers of physics; the investigation of the survival of educational innovations should be more generally useful to educational innovators.

INNOVATION:

This grant is an extension of one which helped support the MIT Education Research Center, founded as the Science Teaching Center in 1960 and dissolved in the summer of 1973. The original funding was for a project of the "old style" of curriculum development, distinguished by its attention to a wealth of learning aids including demonstration experiments, take-home experiments, laboratory experiments, films and so-called documentation experiments which provided honest data for the textbook treatment of a subject. As the project developed it became even more clear that once good curricular materials are available, it is necessary to pay close attention to the context in which they are used. This led to an exploration of alternative learning modes, such as concentrated study, the personalized system of instruction, the walk-in laboratory, project laboratories, and so-called "family-plan" laboratories. Experience with these alternative learning modes led naturally to concern about and study of the survival of educational innovations and ways in which this survival can be encouraged. The present project, although reduced in scope because of the demise of the Education Research Center, still spans physics teaching from the production of curricular materials to the survival of educational innovations.

EVALUATION:

Teaching materials originate out of extensive discussions among physicists at MIT and elsewhere; early drafts are criticized in extensions of these discussions and tried out with different sets of students in various institutions; as materials approach final form, more formal evaluations are solicited. Early trials of non-traditional learning modes were made under advice and review by psychiatrists and social scientists. Several studies of innovations and their professional and institutional contexts have been carried out with the collaboration of Malcolm Parlett, a well-known educational evaluator. These included the analysis of a physics recitation section, a trial of concentrated study, and a study of the survival of the Personalized System of Instruction in the MIT department of physics. Journal refereeing and the exposure of journal publication have provided "public evaluation" of not only insights in physics and physics education developed during the project but also the more comprehensive studies of the organization and survival of alternative learning modes.

MATERIALS:

Basic Texts--Three texts have been published under the authorship of A. P. French and are available from the W. W. Norton Company of New York:

Mechanics (1971)
Special Relativity (1968)
Vibrations and Waves (1971).
Introduction to Quantum Physics (A. P. French and Edwin F. Taylor) is in production.

Films--Several films developed under this project were produced by the Education Development Center. For distributor information write to: Film Librarian, EDC Distribution Center, 55 Chapel St., Newton, Mass. 02160.

The Ultimate Speed
Time Dilation: An Experiment with Mu Mesons
Electron Emission Phenomena (thermionic, photoelectric and field emission)
The Stern-Gerlach Experiment
Interference in Photon Polarization
Energy Eigenvalues in Quantum Mechanics
Single Photon Polarization
Relativistic Ride (an experimental film)
Soap Film Oscillations
Positron-Electron Annihilation

Two series of film loops have also been closely integrated with the materials of this project, one series on the field patterns of moving charges and another series on one-dimensional packets in quantum physics. The production of the two series was funded separately from this project.

Other Teaching Aids--Some other teaching aids have been developed, primarily for the introduction to quantum physics:

A take-home polarized light kit and a pamphlet "Suggested Experiments with Linearly Polarized Light" by W. A. Shurcliff and Edwin F. Taylor

A set of study questions and film stills from the films on one dimensional scattering

A programmed booklet on qualitative plots of wave functions by A. P. French and Edwin F. Taylor

A listing of some teaching aids for introductory quantum physics from various sources.

Copies of the above materials are available from the Project Director.

Reports--A retrospective report on the MIT Education Research Center is being prepared with funds from this grant. The report will contain a bibliography of publications and lists of materials as well as an evaluation of the effects of this and other projects of the Center.

PROBLEMS:

The problems of this project have been principally those common to any curriculum development and educational innovation effort: the difficulty of obtaining and holding the attention of busy research physicists on the hard tasks of detailed curriculum development; the difficulty of understanding why educational innovations succeed and fail in the social contexts of colleges and universities; the soliciting and assembly of student comments and reactions in form and timing suitable for revising materials. We have found no permanent solutions to these difficulties but have taken them into account in making every major decision.

February 1977

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PROJECT NUMBER: SED 71-04427 **AMOUNT AWARDED:** $689,870

DATE AWARDED: June 16, 1972 **DURATION:** 60 months

PROJECT TITLE: UNDERGRADUATE EDUCATION IMPROVEMENT IN POLITICAL SCIENCE: INNOVATION IN INSTRUCTIONAL MATERIALS

PROJECT DIRECTOR: Sheilah Koeppen Mann

PROJECT ADDRESS:

American Political Science Association
1527 New Hampshire Avenue, N.W.
Washington, D.C. 20036
(202) 483-2512

PURPOSE:

To improve undergraduate and pre-professional instruction in political science and the cognate social sciences by involving students actively in social science inquiry and analysis. And to do so by developing prototypes of new instructional materials.

AUDIENCE:

Learning materials are produced for students. Cognate essays on the explication of social science paradigms and analytical frameworks are being developed for faculty and students. The materials can be used in courses primarily for social science students as well as in courses on public problems for science and engineering students.

INNOVATION:

A. Learning Materials

The Development of modular formats for two types of learning materials: 1) Supplementary Empirical Teaching Units in Political Science that are computer based learning packages with a monograph and data set.

2) Units for Learning Analysis in Political and Social Science to specify alternative analytical social science frameworks and the consequences of their application to public problems.

B. Dissemination

A project newspaper, DEA NEWS, that samples learning materials to elicit faculty requests to field test units.

C. Advantages and Impact

A system for new educational publications provides professional incentives to scholars to incorporate recent research findings, along with analytical skills, into class materials. The program has enhanced professional respect for instructional innovation. As a result, there is a commitment by our profession to continue and extend educational development activities.

EVALUATION:

Evaluation instruments and procedures were an early and important activity in order to assure the quality and instructional utility of project materials. Project materials designed for student use are subject to a professional scholarly review and field tests by faculty and students. Project materials designed for faculty use are subject to peer review. The reviews and evaluations are used by the project steering committee project director and developers to determine: 1) the advisability of general distribution, 2) the changes needed to improve the materials prior to distribution, 3) the topics and format for new materials, 4) the assessment of the review and evaluation procedures and instruments themselves in order to contribute to the evaluation process of other educational projects.

Additionally there has been an evaluation of the entire set of project activities for the first phase of funding, 1973-1975. The evaluation included peer reviews by panels of scholars and a survey of political science faculty.

MATERIALS:

The project products are: 1) a series of Instructional Resource Monographs that are guides to faculty on source materials and methods of instruction; 2) modules for students on analytical skills and their application to recent research problems in political and social science; 3) a newspaper sent to all political science faculty and departments that samples the student materials; 4) essays on the analytical frameworks and concepts developed in the student materials. Materials are distributed by the project office. Published materials may be ordered by libraries and college bookstores.

PROBLEMS:

1. The delineation of social science topics and analytical skills suitable to modular units. Social science inquiry and curricula are organized traditionally by broad subfields rather than by the more discrete research questions of the natural and biological sciences.

2. The communication of the attributes of social science inquiry, their comparability and distinctiveness, to scholars in the natural and biological sciences.

ADDITIONAL COMMENTS:

While there are benefits from the exchange of experiences among projects in different disciplines, the professional clientele identify with their academic area and its particular developmental needs. Hence the legitimacy and success of an education project depends first upon the merit and utility of its materials to the faculty who share a professional identification.

February 1977

PROJECT NUMBER: SED 72-05814-A08 AMOUNT AWARDED: $1,261,900

DATE AWARDED: MARCH, 1972 DURATION: 63 months

PROJECT TITLE: HIGH SCHOOL POLITICAL SCIENCE CURRICULUM PROJECT

PROJECT DIRECTOR: HOWARD D. MEHLINGER

PROJECT ADDRESS: SOCIAL STUDIES DEVELOPMENT CENTER
513 NORTH PARK AVENUE
INDIANA UNIVERSITY
BLOOMINGTON, INDIANA 47401
(812) 337-3838

PURPOSE:

The overarching purpose of the High School Political Science Curriculum Project is to develop, test and disseminate an alternative approach to high school courses in American government. The project aims to promote basic citizenship skills and train students to be competent political actors. The year-long course stresses the integration of knowledge, skills and participation experiences so that students can acquire new political science concepts that will help them to understand political phenomena, new intellectual and ethical skills that will help them to reason about political issues, and new participation skills that will help them to act in political arenas more effectively.

AUDIENCE:

The project is being developed for high school students of American government, and teachers who desire to have a choice of an alternative course for their American government classes. There are over one million students taking American government courses each year in the United States. In most high schools, it is a required course. There are over 40,000 government teachers. This is a large audience and a significant slot in the curriculum which makes a fundamental contribution to citizenship education.

INNOVATION:

One of the major innovations of the project is the integration of knowledge, skills and participation experiences. Our aim is to combine these dimensions in order to give the students careful instruction in participation before they engage in actual political action. This type of integration should stimulate interest in the subject matter and the ideas and skills should have greater staying power beyond the classroom.

Another innovation of the project has been to feature the school as a political laboratory through which students could test propositions about politics and engage in participation activity. This activity has created sustained participation roles for students which should have greater transfer into their everyday lives.

Annother innovation has been for students to take a systematic perspective on politics which allows them to view political systems as wholes and to view the consequences of their actions within the context of a variety of groups and associations. Students then participate with full knowledge of systemic patterns through which groups interact, and not just individual interests. As a result of the course, students tend to see politics as a systemic activity rather than one that depends solely on the individual.

EVALUATION:

The project is being evaluated both internally and externally. An internal evaluation has been conducted which includes paper and pencil questionnaires, mastery tests for each unit of the course, teacher logs and on-site evaluation. The project has been field tested for three years involving an average of 35 schools across the United States per year. In each round of the evaluation comments have been fed into the revision of the materials. Over 100 outside consultants have made comments about the course. These consultants include political scientists and social studies educators as well as people in the schools who read the materials and report back their criticisms.

In addition, an outside agency, National Evaluation Systems, was hired to construct mastery tests for the final pilot testing of the course. Their printed reports are available from the Social Studies Development Center. A final evaluation report that will review the evaluation process and its results is also being prepared.

MATERIALS:

The materials constitute a full-year American government course. They are being published by Prentice-Hall, Inc. with a copyright date of January, 1979. Those interested in the materials may receive pilot versions as long as the supply lasts from the Social Studies Development Center. Published materials may be purchased from Prentice-Hall, Inc., Educational Book Division, Englewood Cliffs, New Jersey 07632.

PROBLEMS:

One of the major problems of the project has involved evaluation. Evaluation research includes central problems which are often of only marginal concern to curriculum development. Frustrations occurred when salient research interests of staff evaluators did not coincide with needs for assessing student performance with standard instruments. For these reasons it was difficult to employ full-time professional evaluators as part of the project staff. On the other hand, external evaluation often suffers from problems of geographical distance. Staff experienced difficulties in communication and establishing shared understanding of project goals with external evaluation teams.

The most successful parts of the internal evaluation have been the site visits done by staff to see how the course is working in schools. The most successful component of the external evaluation has come from critical commentary by political science and social studies colleagues. These evaluation procedures are recommended as successful and direct ways to gain information about how a course is working and what goals it achieves.

Some problems other projects have had were not encountered in this case. The project sets a model for a development team working in a single site on a curriculum project. Experience on this project shows that much of the success of the project is due to the housing of the development team at a single site. The staff also found interest in schools to be keen. The main problem has been one of having limited copies of materials, not one of apathy or lack of interest. In addition, support for consistent diffusion throughout the life of the project has contributed to the successful preparation of a network of individuals prepared to use the materials and work with new ideas.

February, 1977

Human Behavior
Psychology
Biology
Anthropology
Sociology

PROJECT NUMBER: SED-73-06337 A04 **AMOUNT AWARDED:** $798,355

DATE AWARDED: January 1, 1974. **DURATION:** 44 months

PROJECT TITLE: HUMAN BEHAVIOR CURRICULUM PROJECT

PROJECT DIRECTOR: John K. Bare

PROJECT ADDRESS:
HBCP
Carleton College
Northfield, Minnesota 55057

(507) 645-4431 ext. 243 or 615
(507) 645-6996

PURPOSE:

To develop 10 modules on human behavior, each designed for 10-15 fifty-minute class periods in the high school. Because teaching about human behavior occurs in a variety of settings, the module format was chosen so that modules could be incorporated into any of a number of existing courses or put together to form a course of a semester's length with the teacher selecting the topics to be included.

Two major problems currently exist in the teaching of high school psychology: there are no materials that include the amount of student activity in demonstrations and experiments that is common in materials for other sciences at this level; and those teaching the courses have not often had the preparation that is necessary. The materials being prepared alleviate both of these difficulties: activity in demonstrations and the planning, design, execution, and interpretation of experiments are a significant feature of the materials; and the teacher handbook for each module provides considerable assistance to the teacher in planning classroom activities and in teaching the module.

AUDIENCE:

Middle 80% of high school students, grades 10-12, with greatest liklihood that materials will be used at the 12th grade. Numbers are difficult to obtain, but the National Center for Education Statistics (HEW) shows the following figures for 1972-73 in their latest publication (1975): 30.2% of total U.S. Secondary Schools offer a course, these schools enrolling 37.5% of total enrolled in high school; 590,370 students were enrolled in psychology courses, an increase of 321% since the 1960-61 figure of 140,377.

It is entirely possible that junior colleges may adopt the materials, and college courses in the discipline may benefit indirectly by having students better prepared.

INNOVATION:

Each of the features of the project has been used by other projects, except for the inclusion of students on the module design teams. What is distinctive is that this project is producing materials on the kind which have not been available in human behavior in the high school but which have been highly successful in other disciplines.

The advantage that is anticipated is that the high school student will have an understanding of human behavior that is not taught anywhere else. Judging by the trials so far, the liklihood of success appears high.

EVALUATION:

When the completed draft of a module is received from the design team in the field, it is reviewed for format and content by the project staff, by members of the 15-person Steering Committee (of distinguished Psychologists) for content, and by members of the 15-person Advisory Committee (of Educators and Parents) for suitability of materials for the classroom and the student. A local trial (two-four schools for each module) is given, revisions as necessary are made by the project staff, national trials are conducted (35 classes for each module), further revisions are made by the project staff, and final reviews are conducted by the members of the Steering Committee and Advisory Committee. (All parents review all modules on both occasions.) In addition, each module is reviewed primarily for but not limited to content by two reviewers independent of the project, chosen by the Americal Psychological Association.

The evaluations are largely formative, and thus are designed to provide information on the basis of which improvements can be made. Data will be collected during the national trials to determine whether the modules teach. It is hoped that the materials will go to the publisher in the fall of 1977.

MATERIALS:

A student booklet and a separate teacher handbook will be developed for the following topics: Brain and Behavior; Changing Attitudes and Beliefs; Conditioning and Learning; Human Behavior and the Computer; Language, Communication and Thought; Natural Behaviors in Animals and Humans; Organizational Psychology; Personality; States of Consciousness; and Social Influences on Behavior. It is expected that they will be available from a commercial publisher.

PROBLEMS:

Perhaps the ideal way for having the original writing done has not yet been discovered. If it is assumed that specialists in the discipline, high school teachers, and high school students should compose the team (and the side benefits of such a design are many), then the choice must be made between bringing the team to the project or having the writing done at the team's location. Both choices have problems. In the first, there is no time for reflection; in the second, the teams find it difficult to meet deadlines. The second choice was made on this project, and the delays must be met by additional overtime work by the staff, for which there is no remuneration.

ADDITIONAL COMMENTS:

Curriculum development is a very difficult, often frustrating, and completely exhilarating experience.

February, 1977.

PROJECT NUMBER: SED74-11549 **AMOUNT AWARDED:** $149,320

DATE AWARDED: June, 1974 **DURATION:** 26 months

PROJECT TITLE: DEVELOPMENT OF SCIENTIFIC CAREERS: THE HIGH SCHOOL YEARS

PROJECT DIRECTOR: Donald H. McLaughlin

PROJECT ADDRESS: American Institutes for Research
P. O. Box 1113
Palo Alto, California 94302
Phone: (415) 493-3550

PURPOSE:

This study grew out of the concern of the National Science Foundation to increase the understanding of the processes by which today's high school students move toward or away from careers in science. Specifically, they were concerned about whether the lack of women and ethnic minorities in science might be related to a lack of some types of career guidance information in high school. In accord with their concern, the National Science Foundation awarded this research grant to study "the career guidance factors that affect the development of high school students' scientific potential."

The rationale for this study was that there are career guidance factors that may be subject to intervention at the high school level, resulting in more successful development of careers in science. In order to investigate scientific career development, a series of seven objectives were set out.

Objective 1: Development of a Scientific Potential index based on differences in high school ability between scientists and others, and observation of the correlates of Scientific Potential. The achievement of this objective allows the isolation of career development factors after controlling for ability.

Objective 2: Identification and measurement of nonability variables that are predictive of establishment of a career in science for individuals with equal Scientific Potential. The achievement of this objective provides us with new understanding of the career developmental process that results in the ultimate utilization of the scientific abilities that high school students possess.

Objective 3: Comparison of differences in Scientific Potential and its relationships to science career plans, among whites, blacks, Orientals, and Spanish surname students, between males and *females, and among urban, suburban, and rural high school students.* The achievement of this objective is the first step towards understanding the problems of unequal access to careers in science.

Objective 4: Identification and measurement of knowledge, about science careers and about one's own abilities and motivations, that is related to the realization of high school students' Scientific Potential through planning for a career in science. This and the following objectives include comparison of results across the various groups of students referred to in Objective 3. The achievement of this objective provides the basis for recommendation of types of informational aids that are most likely to help students to make career plans appropriate to their levels of Scientific Potential.

Objective 5: Determination of the extent to which career development problems are due to misconceptions of career development and can therefore be solved by providing instruction in this area in high school.

Objective 6: Identification of sources of influence and knowledge related to career development. The achievement of this objective allows us to determine what kinds of communication are likely to have the greatest impact on planning for science careers.

Objective 7: Provide the foundation for developing a procedure for evaluation of the effectiveness of high school programs in terms of their guidance of students towards careers appropriate to their scientific ability potential. The procedure of administration of a questionnaire on career development to high school students along with a test designed to assess their ability potential for science careers provides the basis for achieving the objectives listed above; this procedure can also serve as an assessment of the effectiveness of the career education and career guidance programs the students may have encountered. Such a procedure could be applied to various innovative programs in order to select the most effective techniques for wide-scale implementation.

AUDIENCE:

The audience for this project is potentially all individuals interested in the problems of development of careers in science, at the national or the local level.

INNOVATION:

Two distinct approaches were undertaken to contribute some new empirical results to the consideration of the question of what factors are related to science career development during the high school years. The first approach was to determine what types of relevant knowledge high school students lack, so that steps can be taken to provide that knowledge; and the second approach was to analyze the characteristics of high school students who later pursued scientific careers successfully, in order to provide today's students with information they need for making intelligent career plans with respect to science.

The first approach led to the administration of a questionnaire to 1,142 high school students from 11 high schools in eight different communities in California during the spring of 1975. The questionnaire assessed students' career plans, especially with respect to science careers, their levels of career-related knowledge, and the factors they perceived as influencing their career planning. The second approach led to analyses of the responses of some 23,000 Project TALENT participants, including over 1,200 currently in science careers, who took two days of tests and inventories while in the 11th grade in 1960 and who responded to follow-up questionnaires in 1972 when most of them were approximately 29 years old. An index of Scientific Potential was developed on the basis of comparison of the ability differences between Project TALENT's scientists and other respondents to Project TALENT's questionnaires. In both cases, the data bases were designed to be sufficiently representative to enable conclusions to be reached that are relevant to today's students.

The study also addressed the problem of overcoming the barriers that keep particular groups of high school students from pursuing science careers successfully, especially members of racial and ethnic minorities in this country and women. Accordingly, in deisgning the recent assessment of high school students' initial science career development, care was taken to include sufficient numbers of appropriate groups in the sample. However, for the second approach based on Project TALENT, the data were often insufficient for separate analyses of the various groups because of the very small numbers of female and minority students who became scientists. While some results of the Project TALENT analyses are presented for both sexes, few are presented for separate racial/ethnic groups, and for some crucial analyses the white males constitute the data base. Most of the race and sex comparisons, therefore, are based on the 1975 data.

EVALUATION:

The development of the data collection instruments was evaluated by members of the project's advisory panel. Preliminary results were presented to a meeting of NSF staff members six months prior to completion of the study and suggestions for analyses were received. A draft of the final report was reviewed by a leading researcher in the field of science career development.

RESULTS:

More than 3 times as many female high school students were planning careers in science in 1975 as in 1960. Of the 1960 11th grade Project TALENT participants, 32% of the males and 5% of the females had had science career plans in high school. In contrast, 24% of the males and 17% of the females had science career plans in the 1975 sample.

Although the 1975 sample exhibited less sex effect on science career plans, large differences were still evident between various ethnic groups: 14% of the blacks, 15% of the Spanish surname students, 23% of the whites, and 29% of the Orientals had science career plans.

Although students displayed some knowledge of their own abilities, interests, and values, of the characteristics of people in various occupations, and of the educational requirements and salaries in various occupations, there were several distinct knowledge deficiencies that may inhibit establishment of careers in science. Very few differences were evident between the sexes in self-perception and perceptions of careers; the underrepresented minorities, however, were significantly less accurate than others in their estimates of their relative abilities, interests, and values and in their estimates concerning people in selected occupations.

The Scientific Potential index, composed of high school abilities that best discriminate between having a scientific vs. nonscientific job 11 years after high school, fared well in validation analyses. Not only did the ranking of 50 science occupations and 150 nonscience occupations by mean Scientific Potential display a high level of face validity, but also Scientific Potential was found to be predictive of eminence within a sample of science occupations as measured by quality of undergraduate and graduate schools, number of citations in the Science Citation Index and the Social Science Citation Index, and being listed in American Men and Women in Science.

Men and women differed little in mean Scientific Potential. Thus, the underrepresentation of women in science careers is not due to differential development of abilities before and during high school. On the other hand, large differences were found among the four major ethnic groups in the 1975 sample, with blacks and Spanish surname students scoring one standard deviation below whites and Orientals. Thus, the factors that lead to underrepresentation of minorities in science are largely present before high school age.

High school students with high Scientific Potential scores who would not consider working in any science occupation were more likely to be white, to have well-educated parents, and to report lower grades in most or all of their courses than a comparison group of high science ability students who had not rejected all science careers. The number of these students was not as large as one might have expected; seven out of every eight students with high Scientific Potential scores had not rejected the idea of a science career for themselves, although only about 40% were specifically planning one.

PROJECT NUMBER: SED 76-18446 AMOUNT AWARDED: $104,600

DATE AWARDED: June 30, 1976

PROJECT TITLE: "DEMO-GRAPHICS" TEACHING DEMOGRAPHY IN HIGHER EDUCATION WITH COMPUTER-GENERATED GRAPHICS

PROJECT DIRECTOR: Paul Handler

PROJECT ADDRESS: University of Illinois
Urbana, Illinois 61801
(217)333-3827

PURPOSE:

The goals of this program are to develop multi-purpose teaching modules in population and population-related subjects which can be used by instructors in a multitude of disciplines under a variety of classroom situations. The materials prepared are designed to be used by the instructor in a number of different ways: in the classroom as a lecture aid, in the laboratory for students' problems and term paper assignments and as background material to be distributed as study and laboratory problems. The different forms of materials to be prepared will represent a number of media: printed workbooks with examples and problems, slides for large classroom presentations and interactive computer-generated graphics for direct student learning. This last medium has already been demonstrated as being highly effective on the CAI PLATO network. During the contract many of the programs will have been rewritten in BASIC so that they can be used on almost any computer-output device combination. At present, over six institutions of higher learning are experimenting with our UNIVERSAL BASIC POPULATION PROGRAM and our goal is to have approximately 15-20 schools using one or more parts of the program by the end of the first year and as many as 100 schools by the end of the three-year period. The preparation of the teaching modules is based on the idea of single concept presentations which may be used with one or all forms of the media available. The content of the discipline of demography is broken up into a number of single concepts modules, each of which may be presented alone or in sequence. In this way, instructors in various disciplines may tailor their presentations to their individual needs.

AUDIENCE:

The audience is diverse in that it represents professors, instructors, graduate students and undergraduates. The major discipline is demography taught in sociology departments. The second most frequent use is in biology departments and the third is ecology and environmental sciences where instructors usually have had no prior training in demographic techniques. The PLATO Program has been used in a number of disciplines from Agriculture to Urban Planning on the University of Illinois campus, and we look forward to those instructors to continue using the population programs in their courses.

As more and more people become familiar with the program and its multiplicity of subjects, and especially the simplicity of use, the potential audience should become larger and larger. In the PLATO Program for the

Agency for International Development, the original five-year goal was to reach 1000 participants. At the end of the four years, the total number of participants at seminars and workshops had exceeded 13,000 individuals.

INNOVATION:

This program provides new modes of teaching for the following groups:

1. The instructor presently teaching demography.
   a. It provides him with a vast data base of over 130 countries and regions. It allows him to use many more examples. It allows the student the opportunity to make hundreds of more population projections than would be possible during an ordinary course. The system augments the instructor's ability to transfer information.
   b. The data base is accessible through the school's own computer system. No additional hardware costs are required since the UNIVERSAL BASIC PROGRAM will work on a teletype, CRT or any other output device. Only minimal teacher training is involved and in some cases, none at all.

2. Instructors where population is an important element in the course.
   The UNIVERSAL BASIC PROGRAM together with the printed teaching modules and examples allows teachers with little or no prior demographic training to emphasize population as an integral part of the course material. Examples where this has worked so far are Urban Planning, Rural Sociology, social work, ecology and many others.

3. Instructors where population and population-related problems are peripheral to the course.
   In these areas, the population program and structured modules designed to transmit a specific concept can add another dimension to the course material.

EVALUATION:

During the first year and one-half, we hope to gain wide distribution of the program. While we use it in one way at the University of Illinois, we have found that other Professors at the University of Utah, the University of Denver and Dartmouth are using the material in slightly different ways. Therefore, during the second year, we plan to define an evaluation program. At the present time, we believe the number of users at each school will represent a measure of the success of the initial phase of this project. Later a panel of experts will be organized to assist us in evaluating this new mode of teaching.

MATERIALS:

The program materials fall into four categories:

1. Computer Programs and Data Bases
   Three programs are ready at this point in time:
   a. Population Projection
   b. Population History
   c. General Purpose Demographic Model

2. Users' Manuals for Instructors and Students which will enable them to maximize the use of the computer programs.
3. Single Concept Demographic Modules with examples and problems for use by instructors and students.
4. Slides associated with each demographic module for classroom presentation.

PROBLEMS:

The major problem is to make the program easily accessible to each individual. If the computer facilities are in a distant building, the program is less likely to be used. If the accessibility problem is solved, and that now seems to be the case for many schools with time-share systems, then the second most difficult problem is to find instructors who are willing to change their present format of instruction. We are trying to develop the single concept modules to make this transition as easy as possible.

February, 1977

PROJECT NUMBER: SED75-19654 **AMOUNT AWARDED:** $147,560

DATE AWARDED: June 30, 1975 **DURATION:** 36 months

PROJECT TITLE: ALTERNATIVES IN HIGHER EDUCATION FOR INTERNATIONAL STUDIES

PROJECT DIRECTOR: James E. Harf

PROJECT ADDRESS: The Ohio State University
Columbus, Ohio 43210
614-422-8130

PURPOSE: The purposes of this project are four fold: (1) the formulation of a comprehensive plan written by influential scholars from a variety of social science disciplines to meet the future needs of international studies undergraduate education; (2) the identification of new topics in international studies suitable for undergraduate instruction as a result of commissioned, seminal essays by leading researchers which synthesize concepts, taxonomies, terminologies, research findings, issues and analytic skills across the disciplines of social science; (3) the revision of at least five existing sets of educational materials (learning packages) developed under an earlier NSF grant; and (4) the creation of mechanisms (a) through which core scientific concepts and methodologies in international studies can be identified in the future, (b) through which these concepts and methodologies can be incorporated in high quality learning materials, (c) for the mass production of these new materials, (d) for the dissemination of these materials, (e) through which the processes, paradigms, and impact of the primary target groups--the undergraduate community--can be assessed, (f) for the feedback of the results of these assessments to relevant individuals, groups, and (g) for insuring the effective utilization of such feedback for ongoing improvements.

AUDIENCE: The seminal essays and the comprehensive plan for meeting the future needs in international studies undergraduate education are intended for scholar-teachers in the field and specifically for materials developers for use in designing new materials for the undergraduate level. The learning materials themselves are intended for use by the undergraduate instructor at all types of undergraduate institutions. The student audience for the later is primarily those found at the introductory levels in the social science disciplines.

INNOVATION: Four different types of innovation occurs in this project. First, a group of influential scholars from a variety of the social science disciplines worked together to formulate a comprehensive, future orientated plan designed to meet the needs of international studies undergraduate education. Second, as a result of the seminal essays knowledge which is being produced at the forefront of the social science disciplines will be transmitted in some form to the undergraduate classroom. The seminal essays will be publishable pedagogical statements in their own right specifying relevant concepts, methods, and issues related to international studies within the respective social science disciplines, and they will serve as working documents from which subtopics suitable for modular presentation can be developed by other authors. Third, learning packages characterized by specification of educational objectives, flexible construction, multi-media techniques, and ongoing evaluation--developed in previous NSF grants--will have been further refined. And fourth, a knowledge utilization model will be created and put into operation for the development, evaluation, and dissemination of new educational materials.

EVALUATION: The comprehensive plan for meeting future needs in international studies education was evaluated by members of a steering committee of pretigious scholars in the social sciences created by NSF for the purpose of overseeing the project. The steering committee will also evaluate all of the other products and processes developed in this project. In addition, the seminal essays will be disseminated through book form and at national conventions at which other leading scholars in the field will be given an opportunity to assess them. The learning packages themselves have been evaluated in a number of ways: (a) by leading scholars in the field on their substantive content, (b) by pedagogical experts on the extent to which the educational goals are met by the activities in the packages, (c) by faculty using the materials in test form, and (d) by student consumers. Additionally, a subgroup of the national steering committee has evaluated all of the learning packages developed in the earlier project using the criteria of usage and quality measured in terms of the significance of the concepts, choice of the content, organization of the content, appropriateness of methodology, and the use and appropriateness of special resources. Additionally, a professional evaluator will evaluate both the products and the processes created in this project.

MATERIALS: There are several types of materials or products that have or will be developed as a consequence of this project. One, the comprehensive plan entitled "Alternatives in Higher Education for International Studies" submitted to NSF on June 30, 1976 will be revised for the purpose of formal publication. Included with this plan will be a number of papers on the topics of the development, evaluation, diffusion, and field test applications of learning packages. The seminal essays will be submitted to a commercial or university publisher in autumn 1977 in book form. Learning packages developed under the earlier NSF grant are available in draft form through Learning Resources in International Studies, New York City. Learning packages revised under this grant will be published by the University of Pittsburgh's University Center for International Studies and will be available through LRIS. Once final revisions have been made all learning packages will be submitted to a commercial publisher.

PROBLEMS: There are two basic problems associated with the design and implementation of this grant. The first concerned the matter of autonomy concerning the project goals among the several principles involved: National Science Foundation, the Steering Committee, and the Consortium for International Studies Education (the organization within the International Studies Association responsible for the grant proposal and the implementation of the grant). A second major problem concerned the discontinuities of perception among three groups: those submitting the grant who has been actively involved in the development of educational materials, those within NSF who had a different view of the state of the art in international studies, and leading research scholars in the field. The precise objective of the grant--to create a knowledge utilization model which would bridge the gap between the production of knowledge and its dissemination--turned out to be the major problem in the communication among research scholars, writers of educational materials, and NSF. Consequently, although these problems are being resolved, too much time was spent in dealing with them which detracted in the early phases from our ability to maximize resources in pursuit of the project's basic goals.

May 1977

Multi-disciplinary
Social Science

Project Number: SED 74-07283.A03 **Amount Awarded:** $178,345

Date Awarded: November 1, 1975 **Duration:** 24 months

Project Title: DOCUMENTARY FILM PROGRAM: MATERIALS DEVELOPMENT AND EXPERIMENTAL TESTING.

Project Director: Norman N. Miller

Project Address: American Universities Field Staff
Box 150
Hanover, New Hampshire 03755
603-643-2110

PURPOSE:

This phase of a five-year Documentary Film Program is entitled: Materials Development and Experimental Testing. Earlier phases produced 25 films and 25 teaching essays to accompany each film. This project will provide five disciplinary essays and 25 User's Guides. The five disciplinary essays will describe the use of the films and print materials in specific disciplines: geography, comparative education, rural economy, political science, and anthropology. These reports are being written by a team of specialists in the particular discipline who will meet to view all films and review all existing written materials. In addition to these reports, there will be a series of 25 User's Guides, one for each film. The User's Guides will serve as "road maps" to guide the instructor through each film, pinpointing the visual evidence and the teaching concepts found in each scene.

AUDIENCE:

Both the films and the printed materials are intended for undergraduates in the social sciences. The main disciplines using the materials are anthropology, political science, geography, sociology, education, communications, and social psychology. Area courses on Africa, Latin America, the Middle East, and Asia find uses of the materials as would special theme-oriented courses on the role women, environment, human adaptation, political development, political change, agricultural development, rural society, comparative cultures, and others.

Other groups who use the films and film essays include pre-college audiences, community groups, and libraries.

INNOVATION:

Primary innovation is the film format:

Cultures	Themes				
	Rural Societies	Education/ Socialization	Rural Economics	Women	Belief Systems: Political/ Religious
Bolivia	X	X	X	X	X
Kenya	X	X	X	X	X
Afghanistan	X	X	X	X	X
Taiwan	X	X	X	X	X
China Coast	X	X	X	X	X

The format of 5 x 5 makes all films and essays available in multiple ways. Instructors may build presentations in a variety of ways including by theme (e.g. "women") or by culture (e.g. "Bolivia").

The project's other innovative features include the use of "evidential" film as an overarching philosophy allowing instructors to use film as raw data or as evidence; the provision of adaptable, open-ended materials; the use of "film links" in print to signal especially salient sequences in film; and the encouragement of multidisciplinary as well as conventional academic use.

EVALUATION:

The essays were produced in draft form and evaluated in courses using the films at several AUFS member universities. Student and faculty comments on each essay were collated and returned to the authors for re-drafting. A questionnaire and other evaluation forms were used. Class sizes ranged from 24 to 60, at all levels, freshmen to senior. Faculty and on-campus evaluation services conducted the program. Results were used to re-draft the essays and pinpoint particularly salient teaching sequences in the films. The 25 User's Guides are being similarly evaluated

MATERIALS:

25 films, averaging 27 minutes for a total of 10 hours and 16 minutes on five cultures and five themes. 25 film essays of 12-24 pages each plus an Instructor's Guide describing the use of visual evidence in the classroom. Five disci-

plinary essays evaluating the materials for use in specific areas: anthropology, geography, political science, comparative education, and rural economy. 25 User's Guides describing the concepts that can be derived from the visual evidence in each film.

Films are available through media or audio visual centers at University of California- Berkeley, Syracuse University, Indiana University, Michigan State University, and University of Wisconsin- Madison. The films and all print materials can be purchased or rented from Wheelock Educational Resources, Box 451, Hanover, New Hampshire, 03755.

PROBLEMS:

The main problems concern pre-set schedules and failure to meet deadlines by authors. All 25 essays had to be rewritten in light of the evaluation program. Four of them were totally discarded and in two cases, new authors were commissioned.

February, 1977

PROJECT TITLE: SOCIAL SCIENCE EDUCATION CONSORTIUM

PROJECT DIRECTOR: Irving Morrissett

PROJECT ADDRESS: 855 Broadway
Boulder, Colorado 80302
(303) 492-8155

PURPOSE:

The major goal of the Social Science Education Consortium (SSEC) is to improve social studies instruction at the elementary and secondary levels. The Consortium disseminates information about social studies materials, instructional methods, and trends; assists educators in identifying, selecting, and using new ideas and methods in social studies; and provides a forum for social scientists and educators to exchange ideas and views.

AUDIENCE:

The Consortium serves a wide audience -- elementary and secondary social studies teachers; social studies department chairmen; parents and other lay persons involved with the educational process; social studies and education methods professors; college students; and other educators.

MATERIALS AND SERVICES:

The Consortium has a very extensive Publications Program and provides a variety of services to educators through its Teacher Associate Program, Consultation Service, ERIC Computer Search Service, and Resource and Demonstration Center Library. Each of these is described below.

1. Publications Program.

Over 75 publications are available. These include analyses of K-12 social studies curriculum materials, tips for teaching social studies, resources on the social sciences, resources on social issues and professional issues, and the SSEC Newsletter. The publications may be purchased from the Consortium at the project address given above. A publications brochure is free upon request.

ANALYSES. The Social Studies Curriculum Materials Data Book contains over 400 analyses of K-12 social studies projects, textbooks, supplementary and audio visual materials, games and simulations, and teacher resources. Each data sheet includes an overview of the most significant features of the material; specific descriptions of format, elements, and cost; time required to implement the material; characteristics required of both student and teacher; rationale and general objectives; descriptions of content; explanations of teaching methods; and evaluation data. Bound in three large, sturdy loose-leaf notebooks, the Data Book is kept current by twice-yearly supplements.

TIPS PAPERS. These publications provide suggestions for strategies, materials, and resources for teaching United States history, world history, sociology, economics, and political science. Papers about timely topics such as reading in the social studies, aging, and ethnicity are also available. For example, Tips for Teaching Pre-College Sociology briefly outlines what sociology is and the major approaches to it in the secondary curriculum and then goes on to describe in detail selected student learning activities. Teaching resources -- organizations, professional journals, articles and books, and curriculum guides -- are described in the last chapter. Another publication, Teaching Reading in the Social Studies, is a handy source book for classroom teachers, K-12, providing practical strategies, techniques and resources for teaching reading in social studies classes.

RESOURCES ON THE SOCIAL SCIENCES. Excellent background readings on the social sciences is provided in these publications. The basic structure of the disciplines and trends in curriculum development are discussed, and guidelines for teaching are presented. For example, The Status of Political Science Instruction in American Secondary Schools reviews the development of secondary-level instruction in civics, government, and problems of democracy. The major portion of the paper describes the influence of thinking of political scientists on materials. In Toward Geographic Literacy: Objectives for Geographic Education in the Elementary School two goals of elementary education — intellectual development and social education — are discussed, and from these goals specific objectives for geographic education are derived.

RESOURCES ON SOCIAL ISSUES. These publications consist of annotated bibliographies of curriculum materials, analysis instruments and other resource materials on ethnic studies, environmental education, future studies, global education, and values education. The Ethnic Studies Teacher Resource Kit is one example of an excellent resource on social issues for elementary and secondary teachers. Included in the Kit are: 1) Materials and Human Resources for Teaching Ethnic Studies: An Annotated Bibliography which cites K-12 ethnic studies textbooks, audiovisuals, library resource materials, and teacher resources and contains listings of ethnic organizations and publishers of ethnic studies materials; 2) an Ethnic Studies Analysis Instrument which will help teachers determine ethnic content and educational soundness of curriculum materials; 3) Understanding You and Them: Tips for Teaching About Ethnicity which contains sample lessons and teaching activities; 4) What Is an Ethnic Group?, filmstrip/cassette by Educational

Design, Inc., which defines ethnicity; and 5) Teaching Strategies for Ethnic Studies (James Banks, Allyn and Bacon, 1975, 502 pp.) which is a comprehensive source of concepts, generalizations, and strategies at the elementary and secondary levels. Another excellent resource is Values Education Sourcebook: Conceptual Approaches, Materials Analyses, and An Annotated Bibliography. The Sourcebook describes five major approaches to values education and analyzes values education curriculum materials.

RESOURCES ON PROFESSIONAL ISSUES. Topics discussed in these publications include academic freedom and community controversy, child dvelopment, curriculum development, educational change, games and simulations, leadership, resources, and research and trends in social studies education. For example, A Social Studies Professional Library is a select annotated listing of those books which would form the core of any library for social studies professionals. The publication, Social Studies Dissertations: 1969-1973, is a compilation of abstracts of the doctoral dissertations completed in social studies education from January 1969 through March 1973. Three Studies on Perception and Utilization of "New Social Studies" presents results of a survey of teachers from 13 states on their perceptions and use of the "new social studies" materials.

SSEC NEWSLETTER. Published five times a year -- September, November, January, March, and May -- the SSEC Newsletter contains short articles on current topics of interest to social studies educators and announcements of conferences, workshops and new elementary and secondary social studies materials. Subscription rates are $5.00/year (domestic) and $7.00/year (foreign).

2. Teacher Associate Program.

Each year the Consortium selects two or three social studies teachers to come to Boulder to work with SSEC staff The general objectives of the Teacher Associate Program are 1) to add creative and energetic teachers and school personnel to the SSEC staff and 2) to prepare the Teacher Associates to assume an informed and skilled leadership role in the improvement of their own schools and school systems. The Consortium pays one half of the participant's regular salary, up to a limit of $7,000, provided the amount is matched by the Associate's school district. Duties of the Teacher Associates include working in close relationship with the SSEC staff on dissemination programs and inservice workshops; working with school districts throughout the country on identification, selection, and installation of social studies curriculum materials; and writing and editorial work on SSEC publications. A brochure describing the program and application procedures is free upon request.

3. Consultation Service.

Staff are available and will travel to all parts of the United States to consult with school districts in a wide variety of areas including curriculum development, instructional methods, materials analysis and selection, evaluation, new materials, teaching strategies, and trends in the social studies.

4. Computer Search Service.

The Consortium is the sponsoring agency of the ERIC Clearinghouse for Social Studies/Social Science Education (ERIC/ChESS), which is housed in the same Boulder facility as the Consortium. The SSEC and ERIC/ChESS run computer searches of the ERIC data base. Through a computer search of ERIC, educators can find journal articles, curriculum guides, units of study, bibliographies of curriculum materials, conference papers, research reports, program descriptions and many other types of educational documents in the areas of social studies and social science education. Users of the Computer Search Service receive a computer printout containing annotations of journal articles from the Current Index To Journals In Education (CIJE) and/or abstracts of educational documents from Resources In Education (RIE). The cost is only $17.50 for a search that includes up to 50 citations on the printout. Each citation after the first 50 costs $0.10 extra. Write or call for more information.

5. Resource and Demonstration Center (RDC) Library.

The Resource and Demonstration Center Library is one of the largest social studies curriculum collections in the United States. The collection contains over 14,000 elementary and secondary social studies textbooks, audiovisuals, games and simulations, project materials, professional books, social studies reference books, and the complete ERIC microfiche collection. The library is open to the public Monday through Friday from 8 to 5 p.m. and evenings and weekends by appointment.

PROJECT TITLE: DEVELOPMENT OF CURRICULUM AND INSTRUCTIONAL MATERIALS IN APPLIED SOCIOLOGY

PROJECT DIRECTOR: Professor Jiri Nehnevajsa

GRADUATE PROGRAM DIRECTOR: Professor Burkart Holzner

COORDINATOR: Professor Evelyn M. Fisher

PROJECT ADDRESS:
Department of Sociology
University of Pittsburgh
Pittsburgh, PA 15260
Telephone: (412) 624-5606

PURPOSE:

The project is designed to develop a new curriculum and materials and to try out alternative organizational patterns for graduate instruction in applied sociology. Since present instructional procedures and materials are designed primarily for the preparation of future academic teachers and researchers, they need to be supplemented or revised for the education of sociological researchers who intend to work in non-academic settings as well as university-affiliated research centers. The need to do this arises because of a nationally recognized demand for highly qualified applied sociologists. The curriculum includes, in addition to a grounding in sociological theory and analytical skills, training in research through participation in applied projects, internships, and formal instruction on the processes of intervention in social systems and knowledge application.

AUDIENCE:

The project's work is addressed to several different audiences. These include faculty and graduate students in the program, and the department; other graduate departments in the country who are developing similar programs or intend to do this, applied sociological research institutes or programs, and the relevant professional associations. Information has been disseminated through presentations at professional meetings, including several statements at meetings of the American Sociological Association in 1973, 1974, and 1975; and panels at the Pennsylvania Sociological Association, 1976; and the North Central Sociological Association, 1977; through participation of faculty and graduate students in a movement towards forming a section of the American Sociological Association on social practice; publications of books and papers; consultation, colloquia at other institutions and correspondence.

INNOVATION:

The major need for innovation is a comprehensive design for graduate training for sociological knowledge applications. In addition to a rearrangement of the normal graduate curriculum, this involves the following distinct elements:

-- flexible student placement in the program through individual skills assessment

-- use of the case studies method of instruction, involving the detailed analysis of instances of research application

-- supervised research internships in academically-affiliated research organizations and in non-academic organizations

-- development of curricular elements for instruction on knowledge application processes

-- certificate in applied sociology as proof of attainment optionally available to both M.A. and Ph.D. candidates.

EVALUATION:

The program maintains records on student progress and the development of the program. Beyond the assessment through an NSF site visit (1974), evaluation is undertaken on a regular basis by an advisory committee. A paper summarizing the educational, organizational, and scientific experience with the program is in progress. In addition to providing an assessment of the program, the paper is intended to be useful for other departments planning curricula of this kind.

MATERIALS:

-- Conferences and conference volumes. In order to gather and produce in usable form instructional materials on the uses of sociology, the program has co-sponsored a conference on the utilization of sociological knowledge (with the Bureau of Applied Social Research at Columbia University). The resulting volume is scheduled for publication. Two further conferences on "Social Science Research Organizations" and "Policy Assessment in Social Research and Development" are being prepared for the near future.

-- New courses and syllabi: Several new courses had to be developed for the program. They include a seminar, "Theory of Applications," based on books and materials by P. F. Lazarsfeld; Omar K. Moore's workshop "Design of Social Environments;" Burkart Holzner's course "The Sociology of Knowledge Application;" the "Pittsburgh Area Studies" course; and Patrick Doreian's research seminar "Environmental Systems Engineering." Syllabi and associated materials are being made available.

-- Case studies. A considerable number of case studies have been collected. Many have been prepared by faculty and students participating in the program including: "The Uses of Sociology by Presidential Commissions" by P. F. Lazarsfeld and Martin Jaeckel in Mirra Komarovsky (Ed.), Sociology and Public Policy, Elsevier Publishing Company, New York/Oxford/Amsterdam, 1975; "The Utilization of Evaluation Studies" by Patricia Rieker; "The Translation of a Political Problem into Research Terms" by Nancy Ryan; "The Role and Function of the Social Science Consultant" by Anthony O'Dea; "Sociological Practice" by Francine E. Jefferson; "The Use of Social Research in the Study of Birth Control Campaigns Abroad" by Jeffrey Reitz; and "The Use of an Information Retrieval Service by Teachers" by Ruth Love.

-- Learning Center. Under the direction of Omar K. Moore, the Department has equipped a learning center presenting a collection of materials and opportunities for exploring formal models through the use of simulation techniques.

In order to familiarize students with current opportunities in applied social research, students are encouraged to keep abreast of recent literature. Presently Omar K. Moore is serving as the media editor of a new journal on sociological practice

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(Sociological Practice, Human Sciences Press). Students are following the procedure through which experienced researchers keep track of developments and report them to their colleagues.

-- Other materials. The presence of the program has been a catalyst for the preparation of various papers, books and instructional materials not directly supported by the program. These include P. F. Lazarsfeld's and Jeffrey Reitz's book (Applied Sociology, Elsevier Publishing Company, 1975); Omar K. Moore's Social Role and Social Self, Study Guide (University External Studies Program, University of Pittsburgh, 1975); Burkart Holzner's and John Marx's The Sociology of Applied Knowledge (Allyn and Bacon, to be published); along these lines, mention must also be made of Jiri Nehnevajsa's co-editorship of a new international journal, MASS EMERGENCIES, Elsevier, Amsterdam, which will deal with research and planning as it applies to problems of both man-made and natural disasters. The first issue of this quarterly was published in October, 1975.

Statistics
Decision & Control

PROJECT NUMBER: SED 73-10323 AMOUNT AWARDED: $49,949

DATE AWARDED: JUNE 1, 1973 DURATION: 42 months

PROJECT TITLE: A MASTER OF SCIENCE DEGREE PROGRAM IN APPLIED MATHEMATICS

PROJECT DIRECTORS: A. P. Dempster, Department of Statistics
(Telephone: 617-495-5498)

Y. C. Ho, Division of Engineering and Applied Physics
(Telephone: 617-495-3992)

PROJECT ADDRESS: Harvard University
Cambridge, Massachusetts 02138

PURPOSE:

The objective is to establish a master's program covering the fields of statistics, and decision and control, and combining work-experience in a supervised traineeship with academic training stressing self-paced and computer-based materials.

AUDIENCE:

The program is intended to attract students who have majored in mathematical sciences and wish preparation for professional work in the technical specialties of statistics and decision and control. The materials are relevant to students in statistics or decision and control, or to quantitatively oriented students of business, economics, public policy, etc.

INNOVATION:

We have tried self-paced teaching of small groups of students in the summer. We have developed examples-based and computer-based workshop courses which simulate professional experience. We have exposed students to larger projects in the context of a traineeship program.

EVALUATION:

Since the project is small, we have relied on informal written evaluations from the 5 students who have passed through the program, and from teaching assistants who have used the materials. These are helpful in revising materials.

MATERIALS:

The development of three courses and two computerized workshops was supported either partially or in total under this grant. They are:

(1) a course in control theory,
(2) a course in decision analysis,
(3) a course in the introduction of statistics,
(4) a computerized workshop course on data analysis,
(5) a computerized workshop course on optimization.

The first three courses are designed to be used for self-paced study. They utilize various media, including recorded lectures on tape cassettes together with audio-visual material, study guides, homework problems, etc.

PROBLEMS:

The underlying problem with this project is critical mass, which is unlikely to be solved without a much larger investment than is in prospect. The market for published materials is not large enough to be commercially viable, and similarly the effort of polishing, documenting, and maintaining computer materials for export is beyond the resources of the project. Similarly, we have been unable to organize the long term commitment of support from local research organizations required to firmly establish the traineeship program.

February 1977

PROJECT NUMBER: SED75 - 17475 **AMOUNT AWARDED:** $212,673

DATE AWARDED: JULY 1, 1975 **DURATION:** 30 months

PROJECT TITLE:

CIVILIAN EVALUATION OF MILITARY ELECTRONICS CURRICULUM

PROJECT DIRECTOR: George L. Chapman

PROJECT ADDRESS: Trident Technical College, P.O. Box 10367,
Charleston, SC 29411, (803) 553-2375

PURPOSE:

The purpose of this project is to provide a model set of coordinated educational materials for a multi-media approach to the teaching of electronics engineering technology. Adapting written material, videotapes and specifications for electronics laboratory trainers originally developed by the military is expected to reduce the cost which would otherwise be involved.

AUDIENCE:

This product is intended for any college having a degree program (associate or baccalaureate) in electronics engineering technology. Several hundred of these exist nationwide and most of them are experiencing an increased enrollment in this curriculum. Some of the courses would also be usable for higher level technician training.

INNOVATION:

Each course is separated into self-contained modules which present a complete range of topics so that judicious selection will result in a customized coverage relevant to the service area and goals of the particular user.

The mastery learning concept is embraced by supplementing lectures with sound/slide alternate learning programs for students who have difficulty with the pace of the lectures. In addition the videotapes provide basic lectures utilizing extensive visual aids and thus relieving the instructor from the boredom of presenting basic principles routinely each term.

Successful application of the mastery learning concept has already been documented by Dr. Benjamin Bloom and others. The initial feedback here is very favorable with around 10 point increases in average class test grades and zero failures. This is taken to be an indication of successful implementation in this project.

EVALUATION:

Thirteen participating colleges are involved in the development and tryout of the materials produced. All students fill out brief questionnaires upon completing each unit and an extensive questionnaire at the end of each course. Instructors using the material also submit evaluations each term and grade levels and attrition rates achieved will be compared with classes using conventional materials. These data will be analyzed by computer using the services of the South Carolina State Board for Technical and Comprehensive Education. It is planned to publish the results in papers at selected professional society meetings and selected journals.

MATERIALS:

Included are written text materials with study guides listing behavioral objectives and recommended procedures for mastery learning, videotapes with associated student work sheets, homework with solutions, post tests, instructor's guide including pertinent transparencies for overhead projection and solutions to the post tests, sound/slide programs, laboratory work sheets and electronics laboratory training aids. It is anticipated that these will be made available commercially at the conclusion of the project.

PROBLEMS:

An initial problem developed immediately after this project was funded in that the original project director terminated his connection with it. The search for a replacement did not culminate until 9 months later with the hiring of Dr. Chapman. During the interim period essentially the only activity was the search. This will delay the project completion by about six months and is the reason why the initial feedback on results is just now becoming available.

The only other problem of any consequence has been the long procurement times for some components needed to construct the electronics laboratory trainers. This problem has resulted in a delay of one term in the tryout of one course. Fortunately it is early enough in the overall calendar of events that no delay in the completion of the project will occur as a result of this problem.

ADDITIONAL COMMENTS:

The original plans for this project entailed purchasing the electronics laboratory trainers custom made commercially. The new director did not view this as a viable alternative because of the need to revise specifications and adapt the trainers to the civilian needs. As a result they are being constructed in-house by students attending school on the cooperative work/study plan. Engineering design specifications developed by the Project Director and the Associate Project Director, both of whom are experienced engineers, made this possible.

The sound/slide alternate learning programs which are proving to be a key part of the output were also not envisaged initially. They have been added with no increase in overall budget as a result of savings accruing from the in-house production of all materials.

February, 1977

PROJECT NUMBER: SED 75-18479 **AMOUNT AWARDED:** $93,000

DATE AWARDED: May 15, 1975 **DURATION:** 16 months

PROJECT TITLE: DEVELOPMENT OF A TWO YEAR PROGRAM IN SCIENCE TECHNOLOGY (PHASE II)

PROJECT DIRECTOR: Robert A. Haberstroh
College of the Virgin Islands
Kingshill, P.O. Box 84
St. Croix, USVI 00850

PURPOSE:

This project had as an objective the development and implementation of a program leading to an A.A. Degree in Science Technology at the College of the Virgin Islands. The island of St. Croix has had an infusion of industry within the past 20 years, including an oil refinery and an alumina plant, but there has been no post-secondary training in the technical areas. The high unemployment rate among West Indians, together with the fact that the heavy industries imported most of the skilled labor, mandated projects of this type.

AUDIENCE:

The program which has been developed is aimed not only at graduating high school students, but also at those who already have laboratory jobs, and seek to improve their knowledge and skills (and thus their job rating).

INNOVATIONS:

An experiment in rotating class schedules in chemistry to accommodate part-time students who work shifts had to be modified due to financial considerations. Now, one lecture section is offered in late afternoon, with separate laboratory sections in daytime and evening.

Furthermore, the installation of a two-year technical degree as part of the curriculum of a liberal arts college is itself an innovation. In particular, the Technician Practicum is the first "co-op"[1] type course to be approved at C.V.I.

EVALUATION:

A seven-member Advisory Panel, consisting of representatives of heavy and light local industry, government, public and private high schools, and experts in technology programs, offered information, advice, and criticism on course content, recruitment, administration, and employment opportunities throughout the grant period.

MATERIALS:

In order that the project could concentrate on curriculum development, and the logistics of implementation, previously developed materials were used in all new courses.

PROBLEMS:

The only substantial problems were fiscal. The program is now proceeding, using part-time instructors in all new courses. It is hoped that funding will be available for full-time faculty in the near future.

COMMENTS:

Approximately fifteen students are now involved in the Science Technology Program at C.V.I. (about half of them part-time students). The advanced courses, including the Technician Practicum, will be implemented in the 1977-1978 academic year, by which time equipping and staffing of the Program should be on its way toward completion.

February 1977

AGREEMENT NUMBER: SED 74-22936 AMOUNT AWARDED: $1,000,000

DATE AWARDED: September 10, 1974 DURATION: 34 months

PROJECT TITLE: ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION (ERDA) TECHNOLOGY TRAINING PROGRAM (TTP)

PROJECT DIRECTOR: James R. O'Gwin

PROJECT ADDRESS: Division of Labor Relations
Energy Research and Development Administration
Washington, D.C. 20545
(202) 353-4818

PURPOSE:

To utilize ERDA government-owned facilities operated by private contractors to develop training programs for technical manpower in emerging and expanding energy-related occupations. Specific objectives of the project are the following:

- To demonstrate on a nationwide basis the feasibility of utilizing the training capabilities within government-owned installations to respond to local and regional manpower shortages in selected energy-related occupations.
- To develop improved methods of technical training by establishing cooperative relationships among industry, education, and government.
- To enhance energy technology transfer by providing technical training for non-ERDA organizations and by transferring to education and industry institutions instructional material related to emerging needs in energy-related technical occupations.

AUDIENCE:

There have been 12 training projects initiated in 8 ERDA contractor facilities. The projects are structured to provide energy-related skill training to unemployed persons seeking technical employment or to currently employed individuals that need to upgrade their skill knowledge and application of energy-related technologies. Nine of the training projects had, as a minimum, 30% participation of women and minorities.

Curriculum material developed has been made available to education institutions and energy industries for use by students, instructors and employees. The training projects are having an impact beyond those individuals and organizations directly involved in the programs. A multiplier effect has been achieved as individuals, who have received training, are able to pass on their newly acquired skill knowledge and application techniques to others; and education institutions incorporate the training instructional material into their curriculum.

INNOVATION:

The Technology Training Program (TTP) has been the catalyst to implement training projects at the technician skill level within ERDA installations to assist other energy-related employers. A distinctive characteristic of TTP is the combining and coordinating of financial and training resources from several groups to achieve technical training of a higher quality than any single party could provide alone. The principal partners in TTP are ERDA and ERDA contractors, educational institutions, and CETA prime sponsors.

ERDA contractors are involved in advanced research, development and demonstration projects in expanding and emerging energy areas. The technical skills and subject matter content required for persons working in the ERDA energy projects can be directly translated to produce needed technicians for other employers. The TTP partially funds training in high-technology occupations where training is either not available or insufficient in local education institutions and private industries.

The training projects are conducted within ERDA laboratory and production facilities using modern equipment and advanced techniques with instruction provided by the professional and technical staff of the contractors. Training is designed to provide the trainees with the current skills utilized by the contractors and prospective employing companies.

Community colleges and other educational institutions provide educational assistance and trade-related instruction. Seven of the projects have developed training components for which the participants receive college credit. Curriculum materials are made available to educational institutions and private companies.

CETA prime sponsors and other manpower resources in each community served are mobilized as participants for developing mutually beneficial programs. Five TTP projects have received local CETA funding.

The benefits from establishing such cooperative relationships extend beyond the human resource development realized through improved technical training in TIP. Opening communication channels among industry, education, and government will facilitate future cooperative efforts to achieve mutual manpower goals.

A brief synopsis of each training project follows:

Aerojet Nuclear Company, Idaho Falls, Idaho

The Radiation Safety Technician program is a joint training effort between Aerojet and the Eastern Idaho Vocational Technical School. The participants receive over 400 hours of on-site laboratory instruction and work experience to supplement the EIVTS curriculum. This project has demonstrated a high degree of success, and ERDA management is committed to continuation of the program with ERDA funding.

Atlantic Richfield Hanford Company (ARHCO), Richland, Washington

A Nuclear Technology Training program has been initiated by ARHCO in cooperation with Columbia Basin College. A significant element of this joint human resource project is the development of an introductory course to Nuclear Breeder Reactor Technology by ARHCO. The introductory course will be completed by September 1977 for dissemination to education institutions with a Nuclear Technology curriculum.

Lawrence Livermore Laboratory, Livermore, California

A minimum of 150 persons from private industries and government organizations engaged in energy-related work are being upgraded in 2- to 4-week short courses. The courses are being custom designed to meet employer/employee needs in microprocessor technology, digital technology, welding and bonding technology, and joining and fastening techniques. The courses have been videotaped for trainee use and the completed tapes are being made available to companies and education institutions.

Lovelace Foundation, Albuquerque, New Mexico

The two 1-year Inhalation Toxicology programs are training specialized technicians not available from any other source. Research is increasing in the inhalation of aerosol particulates in nuclear and fossil programs as well as numerous aerosol sprays.

Joint TTP and ERDA operations monies have developed the training capability of Lovelace to meet both its own needs and the needs of others. The trainees spend 10 hours a week in formal classroom training, and the balance of the 40 hours' week is spent in skill application under the guidance of an experienced inhalation toxicology professional.

Reynolds Electrical and Engineering (REECO), Las Vegas, Nevada

A 6-month training program for Radiation Monitors stressing extensive real work training experiences has received full training cost support for 40 trainees from the local CETA prime sponsor. The program was designed for females and minorities. Also, Clark County Community College (CCCC) is granting up to 30 hours of college credit.

In addition, REECO and CCCC have established an intensive 6-month work-study Industrial Hygiene Technician Training project. This pilot project is designed to assure that the trainee acquires the necessary knowledge and skill application ability to perform as an industrial hygiene technician plus additional related skill ability in industrial safety, occupational medicine, fire protection and radiological safety. The scope of the instructional material will enable the trainee, upon completion of the training, to perform the varied duties required by the Occupational Safety and Health Act of 1970.

Three pilot 2-week courses in Emergency Response Training were funded to provide technical training to state government personnel to respond to potential fixed nuclear facilities and nuclear transportation accidents. Based upon the demonstrated success of this pilot effort, a Federal Interagency Task Force is seeking continued support to designate and fund REECO as a national training center for intensive radiation response training.

Sandia Laboratories, Albuquerque, New Mexico

Sandia, working closely with Albuquerque Technical-Vocational Institute (T-VI), is conducting two 9-month programs to train minorities and females as Electro-mechanical and Construction Draftsmen. The program incorporates industrial work experience with a vocational school curriculum and the students receive subsistence from CETA. Sandia hires the trainees as employees for the last 10 weeks to give them occupational drafting experience.

Thompson Van Bebber Directional Drilling Services (TVD),
Las Vegas, Nevada

Thompson Van Bebber Directional Drilling Services (TVD), an ERDA support contractor at the Las Vegas test site, has been funded to develop a formal 6-month training project in Directional Drilling. The project has received full training cost support for 10 participants from the local CETA prime sponsor. Clark County Community College cooperated with TVD in the project design and is offering instructional support in the academic portion of the project. With the expansion of oil, gas and geothermal drilling activities, the graduates of this project are in great demand.

Union Carbide Corporation/Oak Ridge Associated Universities,
Oak Ridge, Tennessee

The Welding Inspection Technician program, conducted by the two ERDA contractors, is a pilot program to train predominantly females and minorities in an area of critical technician shortages. The program is being jointly funded by the State of Tennessee CETA within the Training and Technology program which the two ERDA contractors have operated since 1966.

EVALUATION:

A data collection system has been implemented to obtain: enrollment, training evaluation, exit, and 4-month follow-up information on each trainee. The individual and composite programs will be compared to similar local training efforts and, if possible, to results of the ongoing national CETA study. The evaluation from the perspective of the persons trained will be assessed on skills obtained, immediate economic benefits and expected future income.

Preliminary evaluation has focused on the catalytic effect of the TTP seed money in establishing programs to train for others within the ERDA system. All eight TTP contractors are implementing additional efforts with other funding sources and other ERDA contractors have also expended their outside training efforts.

MATERIALS:

Curriculum materials are being collected from the programs. An evaluation of the trainees and the individual programs can be obtained from the Project Director along with status reports.

PROBLEMS:

All operational problems encountered in establishing the training projects have been satisfactorily resolved. However, some contractors are experiencing difficulty in obtaining catalytic development funds from local sources to expand the training projects into new technology areas. These difficulties stem partially from the fact that the major source of local funding support, CETA prime sponsors, is directed primarily toward training operational costs together with trainee support and not program development funding. Thus, some level of Federal support in combination with local support will be required to assure continuation of program development into new and emerging energy-related technologies.

February 1977

PROJECT NUMBER: SED 75-17321 **AMOUNT AWARDED:** $81,300.00

DATE AWARDED: June 1, 1975 **DURATION:** 21 months

PROJECT TITLE: A DEVELOPMENTAL GUIDE FOR THE ESTABLISHMENT OF BACCALAUREATE TECHNOLOGICAL PROGRAMS

PROJECT DIRECTOR: Kenneth Woolf

PROJECT ADDRESS:
Department of Industrial Technology
University of Southern Mississippi
Hattiesburg, Mississippi 39401
Telephone: (601) 266-4293

PURPOSE:

The purpose of this project it to develop a sequencial decision model which can be used by administrative personnel at an educational institution, to guide the development of technological programs at the baccalaureate level. In addition, sample data collection methods and instruments for obtaining the information needed to reach these decisions, will be provided. The rationale for each recommended step in the developmental process will also be included.

Hopefully, the availability and use of this Guide will result in less incidents of program failures due to inappropriate curricula, insufficient interest and support, and direct opposition from duplicating programs.

AUDIENCE:

This Guide will be directed toward utilization by college and university personnel who are responsible for the initiation of technological programs. The content will not be restricted to any specific stratum of authority. It is expected that all levels of academic administration will find portions of the Guide relevant.

While the intent of this project is to aid the development of baccalaureate programs in technological disciplines, it is also expected that the procedures recommended in the Guide will be equally as applicable in the development of other post-secondary technological programs.

INNOVATION:

A successful technological program is not the sole creation of one institution or its faculty and staff. The contributions of many academic, industrial and societal publics must be coordinated in support of a viable and successful technological program. This project is based on the premise that these publics must be consulted at the inception of a technological program and that this interaction must be continued throughout its development. This project will apply a systems approach to technological program planning in addition to other management techniques.

EVALUATION:

Two evaluations are necessary in this project. One is that which is made of the Guide content material during its development. The other is that which must be made of its worth as a working document. The former has been a continuing exercize and has been accomplished primarily through the three national advisory committees which represent the industrial, administrative, and instructional publics. These committees have met independently and collectively throughout the Guide's development, to provide these valuable assessments.

The latter evaluation will commense after the Guide has been completed, distributed and implemented. Presentations before professional society conferences and workshops will elicit evaluative comments through peer review. Perhaps the best evaluation will result from an assessment of those programs that are developed in accordance with the procedures recommended in the Guide. This will be conducted through the sampled opinions of the students, employers, faculty, and administration.

MATERIALS:

The Guide folder has been designed to accommodate the addition of supplementary material by the user. The content is structured in such a way as to allow for cross-referencing between one section and another. The written format is the same in each section and graphics are utilized to emphasize points of particular importance. The graphics take the form of flow-charts, diagrams, and stick-figured sketches. Copies of the Guide will be made available through the National Science Foundation.

PROBLEMS:

The greatest problem that has negatively affected the timely completion of this project is related to the delays that appear to be inherent in dealing with large and complex institutions. Requests, authorizations, payments, purchases, and other necessary transactions have often been delayed due to involved and sometimes cumbersome procedures. While completion of the Guide will be within the proposed schedule, it is apparent to the Project Staff that more time should have been allowed for expediting paperwork and activities that are critical to the completion of the project.

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PROJECT NUMBER: SED72-07726 A01 AMOUNT AWARDED: $77,995

DATE AWARDED: July 1, 1972 DURATION: 45 months

PROJECT TITLE: TWO SEMESTER GRADUATE SEQUENCE IN TRANSPORTATION ENGINEERING

PROJECT DIRECTOR: Joseph V. Foa

PROJECT ADDRESS: The George Washington University
Washington, DC 20052
(202) 676-6149

PURPOSE:

The purpose of the workshop is to acquaint the students with the increasingly complex problems of transportation--with particular attention to urban transportation--and to stimulate in them the kind of thinking that is required for a creative and realistic approach to their solution.

The students are brought together in the first semester of the sequence for a joint study of the land-use objectives and transportation needs of a selected geographical area, and for a survey of pertinent information and applicable solutions. In the second semester the students apply their collectively acquired knowledge to a study in depth of specific transportation or transportation-related problems of the selected area.

AUDIENCE:

The class is a mix of engineers and nonengineers (including urban and transportation planners, economists and social and political scientists). Groups that benefit from the workshop indirectly, through its published output, include local governments agencies, transportation planning and consulting firms, and academic institutions.

INNOVATION:

Two aspects of the project are particularly novel and noteworthy.

(1) Each student is required to choose a pertinent aspect of the problem within his field, to study it in depth, and to participate in the capacity of a "specialist" in his chosen subject in weekly conferences with his fellow students and with the teaching staff in the course.

(2) The teaching staff is multidisciplinary. It comprises faculty members and consultants with special competence in "hard" engineering (civil, mechanical, electrical, and aeronautical), operations research, transportation planning, and urban and regional planning.

EVALUATION:

The workshop has been subjected to continuing evaluation by participating staff and students, and has undergone radical changes from its initial to its present form.

MATERIALS:

(1) At the end of each year-long project the most significant term papers written by the participating students are collected in a volume for distribution to governmental agencies, planning commissions, and other interested organizations in the geographic region under study, and to interested individuals or groups anywhere. Five volumes have thus far been released in this manner, involving (1) Transportation in Arlington County, Va., (2) Dulles Airport Access, (3) Related Problems of Transportation in Washington, (4) Topics on Transportation in the Baltimore Region, and (5) Topics on Airport Access in the Washington Metropolitan Area. The last four of these are also available through the National Technical Information Service (5285 Port Royal Road, Springfield, Va., 22151), as documents PB 220 074, PB 260 829/AS, PB 244 341/AS, and PB 258 900/AS, respectivel

(2) A detailed account of the development of the workshop, of the difficulties encountered, and of its final structure and operation was issued on the termination of the grant.

PROBLEMS:

(1) Project starts are often slowed down by student uncertainties in their individual choice of study area;

(2) it is difficult to time and sequence invited talks by outside speakers so as to produce the greatest possible benefits to the entire team;

(3) engineering students have a propensity for choosing topics of study outside their field of competenc and, most importantly,

(4) as in all multidisciplinary efforts, the maintenance of uniformly high standards in all aspects of the study presents great difficulties.

Difficulties (1) and (3) have been overcome through improved guidance and increased vigilance on the part of the staff. Difficulty (2) is being alleviated as the staff gains experience in management of the workshop, but cannot be completely eliminated. Problem (4) is one that is inevitably encountered also in the real world of planning and decision making. Experience with it in the Transportation Workshop is, therefore, not entirely void of educational value.

ADDITIONAL COMMENTS:

On the basis of the experience gained in this program, the following guidelines may be suggested for the organization and management of a graduate-level interdisciplinary workshop in transportation Engineering:

(1) The workshop should be open only to students who already possess some professional experience or some academic background in either transportation technology or transportation planning.

(2) Every effort should be made to achieve reasonable balance between engineering and nonengineering backgrounds in the working team.

(3) Responsibility for the operation of the workshop must rest on a single faculty member, but guidance in each project must be provided by a multidisciplinary panel. It is not necessary that all members of the guidance staff be present at every meeting of the workshop, but under no condition should guidance be provided by one person alone.

(4) It is highly desirable that each member of the guidance staff prepare, in advance of each project, a list of suggested topics for individual student research and a list of reading material or other sources of information for each topic.

(5) Whenever possible, government officials of the region under study should be invited to present background information, as well as their own personal views, on the region's transportation problems, at an early session of the workshop.

(6) Workshop students should be encouraged to seek and maintain direct contact with government officials of the region they are studying.

(7) All participants must be made to keep their individual researches within their own respective fields of greatest competence and/or experience.

(8) Every term paper should be read and evaluated by more than one member of the guidance staff.

(9) Constant vigilance is required on the part of the guidance staff in each project to keep individual presentations from becoming either esoteric or frivolous, to make sure of the validity of all information introduced in the study, and, in general, to protect the credibility of the project.

February 1977

PROJECT NUMBER: SEDR-7412421 AMOUNT AWARDED: $119,500

DATE AWARDED: June 1, 1974 DURATION: 6/1/74-5/31/76

PROJECT TITLE: DEVELOPMENT OF INSTRUCTIONAL PROGRAM AND MATERIALS FOR A NON-RESIDENT GRADUATE DEGREE IN TRANSPORTATION

PROJECT DIRECTOR: James P. Romualdi

PROJECT ADDRESS: Carnegie-Mellon University
Pittsburgh, Pennsylvania 15213
412-621-2600, Extension 106

PURPOSE:

The project develops and tests credit courses in transportation engineering and planning that can be taken by professionals in the field who cannot take the time from work or family to return to full-time graduate study. A major effort was geared toward maintaining high academic standards and avoiding the connotation of correspondence courses. Preliminary plans required the students to visit the campus for two or three days at the beginning and end of each course, the latter to include a final exam. Course modules were prepared for the off-campus portion. Arrangements were made for free telephone contact with the instructor at predetermined weekly periods (i.e., telephone hours rather than office hours).

AUDIENCE:

The program is intended for professionals actively pursuing careers in transportation. For the most part, such persons have a traditional undergraduate degree and are not acquainted with recent developments in transportation planning procedures. It is expected that, for the most part, the participants will be with public agencies, although employees of private firms or corporations would find it convenient to develop their skills in this manner. An undergraduate degree in engineering, economics or urban planning is required.

INNOVATION:

A primary innovation is that the courses are for full academic credit. A further innovation, in an attempt to avoid the sense of remoteness associated with "correspondence" courses, are the required visits to campus. This is strengthened by the provision of free telephone contact with the instructor at predetermined hours arranged during the initial campus visit.

MATERIALS:

One complete course module in statistics has been prepared. Information can be obtained from the project director.

PROBLEMS:

Initial planning for the program was preceded by a survey to establish potential interest in such a program. Results were highly encouraging. Response to the first offering (statistics), however, was disappointing and the course was held off. Discussion with persons involved with continuing education programs elsewhere revealed a similar phenomenon: indications of high initial interest but little interest at the time of enrollment. We suspect that the initial offerings were too fundamental and not closely related to job needs.

To further understand the reasons for the disappointing response, a meeting was held with personnel officers of several state department of transportation officials. They revealed that a graduate degree or additional credit courses do not contribute significantly to employee advancement. Rather, employees (at least in state transportation orgainizations) express the need for short management courses,for example, in the belief that they lead to near-term payoffs.

Through the auspices of the several state transportation departments, questionnaires were sent out by means of state mailing channels to several thousand state transportation professionals. Analysis of the results is currently under way.

The program to date has revealed an interest in non-resident (or off-campus) credit courses that does not appear sufficiently large for full-scale exploitation. Immediate plans call for attempting to provide off-campus continuing education modules to persons who attend the more traditional short type of non-credit courses. Thus, their acquaintance with the material and their presence on campus for one or several weeks might encourage them to explore the material in more depth. The issue of whether or not the work should lead to academic credit is yet to be decided.

PROJECT NUMBER: SED 75-18487 **AMOUNT AWARDED:** $55,700

DATE AWARDED: JUNE, 1975 **DURATION:** 18 MONTHS

PROJECT TITLE: DEVELOPMENT OF AN URBAN PLANNING TECHNOLOGIST PROGRAM (PHASE I)

PROJECT DIRECTOR: Ralph G. Crum

PROJECT ADDRESS: Youngstown State University
Youngstown, Ohio 44555
Phone: (216) 746-1851, Ext. 385 or 497

PURPOSE:

The purpose of this project is to develop instructional units and model curricula in Urban Planning Technology.

AUDIENCE:

The results of the study will serve as a national model for other universities, colleges and technical institutes. Planning and public works agencies, housing and zoning departments, planning and engineering consultants will benefit from employment of graduates of the program.

INNOVATION:

The technologist will be a "doer". He will complement the politician, social scientist, planner, and untrained public employee. An extensive survey has indicated the skills required of the technologist. In-service training will also be surveyed.

EVALUATION:

A steering committee composed of educators, public works officials, planning agency officials, and planning/engineering consultants has begun and will continue evaluation. There are 18 members from across the nation. Some will be utilizing trial instruction units at known locations. Members of the committee can be furnished on request.

MATERIALS:

1. Skills survey results from local, regional and national coverage of city planning, regional planning and public works agencies plus consulting engineers and planners.

2. First phase development of instructional modules in:
    - a) Mapping and Graphics
    - b) Documentary Data Sources
    - c) Informal Communications

2. (Continued)

   d) Formal Communications

   e) Primary Data Generations and Interpretations - Public Works

   f) Building Codes

   g) Construction Materials

   h) Quantitative Methods

PROBLEMS:

Identity of a paraprofessional planner versus a highly-skilled technically trained person working in the urban area with both planning and engineering professionals. The resolution of this problem will require time for agency officials and consultants to realize the value of graduates and in-service trainees of the program.

ADDITIONAL COMMENTS:

An abridged summary report is available upon request.

February 1977